[ESTABLISHED 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE, INC.
140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager
F. H. THOMPSON, Advertising Manager.

Editors:
E. A. AVERILL. R. H. ROGERS

V. C. JONES, Western Representative
407 Medinah Bldg., Chicago

APRIL, 1911

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THE INFLUENCE OF CLEANLINESS AND ORNAMENT

Everybody has heard that cleanliness is next to godliness. It is certainly true that cleanliness has a potent influence on those who come within the circle of its spell. Practiced in daily life, it breeds self-respect and commands the respect of others; practiced in the shop and on the engine, it prompts care and economy in the performance of work, and practiced in the office it expedites business and adds a tone of respectability to the plainest furnishings. The transition from cleanliness to ornament is an evolutionary step that under proper conditions and within reasonable limits gives tone to the good influences of cleanliness. In this and some other ways ornament may prove useful and valuable. The popular love of ornament is shown in nearly every home where means permit, and its refining influence is attested by the fact that in the homes of the most cultured special consideration is given to it.

All are familiar with the importance given to ornament in passenger car construction, especially private, parlor and sleeping cars. Much has been said about the over-ornamentation of cars, and doubtless extremes have been reached, but the attention given the matter has not been without reason. Those who have to deal with passengers know that this feature is so pleasing to them that once employed it is required. Cabooses are sometimes tastefully ornamentad by the crews belonging to them. The influence is good, and probably causes more zealous flagging by the rear brakeman while on the road, and less hours spent by the crew about saloons while at terminals.

The interiors of shops do not offer inviting opportunities for ornamentation, but very frequently the yards about the shop do. A few strips of greensward and a few beds of flowers tastefully arranged make a vast improvement in the appearance of an otherwise clean but barren looking space. The effect of such a change is not lost on workmen, for love of the beautiful is human, and nothing can be lost by making a place of work attractive. It is gratifying to note that after an unwarranted lapse of many years such decoration of railroad shop and station grounds is again becoming popular, and doubtless the time will come when its advantages will be much more apparent.

The influence of cleanliness on shop and engine men encourages careful habits which result in efficient and economical work; it encourages and facilitates the inspection of cars, and especially locomotives, which leads to economy in repair and fewer failures on the road, and the influence of ornament, where judiciously applied, is pleasing and elevating, and encourages and confirms careful habits.

OIL VERSUS GREASE LUBRICATION

The recent action of a prominent Eastern railroad in reverting to the use of engine oil for pin and journal lubrication, after two or three years' practically exclusive employment of grease, constitutes a move of general interest in view of the fact that the latter compound has become so generally adopted in every branch of locomotive service, and has proved so largely exempt from complaint or criticism. In the specific case to which reference is made there was no fault to find with the grease failing in its appropriate business as a lubricant, as the records of the motive power department in question are said to indicate a decreased number of hot bearings over the period when oil was in universal use, but there is another and somewhat unlooked for reason advanced for its abandonment.

The latter is found to be the increased wear of bearings under grease lubrication, and it is said that this condition reached proportions which could not be defined other than startling. One crank pin showed a wear between shoppings of 3/16 in. on grease, and a reduction of ⅛ in. in the nominal diameter of these parts was not uncommon. It was in fact the returns from the various repair shops indicating an abnormally large number of crank pin renewals which first attracted attention to the matter,

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and resulted in the inauguration of a thorough and systematic inquiry. This latter brought to light a similar condition in driving journals, and by subsequent tests, in which one side of an engine was run on oil and the other side on grease, it was satisfactorily demonstrated that the proportion of wear was vastly in excess where the latter was in use. Thereupon the gradual return to oil was made until at this writing it has no doubt entirely supplanted its competitor.

While this investigation is of unquestioned interest it is still a matter of doubt in our mind as to whether it will be generally accepted as conclusive. Even admitting the accuracy of the information at hand the question naturally arises if it would not be better to countenance this wear in view of the admitted results in decreased engine failures which have followed the introduction of grease? The profusion of hot boxes which previously attended the use of oil in heavy service, arising largely from inattention and improper packing, were attended by a full quota of scored journals, and we feel safe in asserting that much more metal has perforce been turned off to straighten these up than was ever worn away by grease impact.

The fact that the driving box lubricator takes care of itself, maintaining a constant and uniform contact with the journal, and requiring no attention other than refilling at periodic intervals establishes points of superiority in its favor over the old arrangement that will prove very difficult to offset. It should also be recalled in this connection that the underneath arrangement of the modern locomotive is necessarily complicated, and its driving box cellars in many instances are largely inaccessible, without a great deal of work, to the frequent repacking which appears to be demanded where waste cellars are used. A contrivance, therefore, becomes a necessity which will limit this operation to the longest period of time, and this is attained in the grease cellar, which is another strong point in its favor.

In view of the length of time which grease 'ubrication has been in vogue it seems rather surprising that a similar criticism regarding wear has not materialized in some quarter heretofore, but no such instance can be recalled, and it does not seem to appear anywhere as a matter of record. It appeals to us, all things considered, that it would be far more to the point to contend with the increased wear, while making every effort to minimize it, than to return to the unpleasant conditions of former times. We all know that box packing was a very much slighted and actually abused proposition of the old days, and that the welcome advent of the driving box lubricator cleared up a general situation which might well be termed as distressing.

AUTOMATIC STOKERS

It has been reported a number of times in the past that a successful locomotive stoker had finally been designed, but a year or so later it has been found that it is still in the experimental stage, and finally it has practically disappeared from view. This is not meant to reflect in any way on the reporters, since there is no doubt that there have been several automatic stoker designs which would successfully maintain the steam pressure of the locomotive under very severe conditions, and from this standpoint they have been successful, but experience has clearly shown that the mere ability to distribute large amounts of coal in proper form to be burned and thus maintain steam pressure, does not constitute a success, although, of course, it is an essential feature of a successful machine of this kind. A really successful stoker, however, must, in addition to this, be reliable to the last degree. If it is not capable of operating continuously with a reliability at least equal to that of the air pump it cannot be considered an entire success. Further, it must be rugged enough to do this without any unusual attention in the roundhouse. No doubt when stokers come into more general use it will be found advisable to organize a small force in the roundhouse for their inspection and repair, practically the same as is now maintained for air brakes. While it can hardly be expected at the start, the successful stoker must finally prove itself to be in the same class with the air brakes and injectors and should be treated in the same manner at terminals.

Fuel economy is by no means an essential feature of the successful locomotive stoker. There will probably be no stoker designed which will be capable of equaling the economy of the very best hand firing, but they should, and in fact are at present doing better than the average hand firing in this respect. There are attractive prospects in the possibility of using a grade of fuel which cannot generally be fired successfully by hand, and along this line considerable economy can be expected. The ability to handle quantities of coal beyond the limits of hand firing will, of course, be demanded of the automatic stoker, and while it is desirable to burn this as economically as possible, the first essential is to burn it and maintain the steam pressure. An increase in the "horse power of the fireman" is the constantly increasing demand of present conditions.

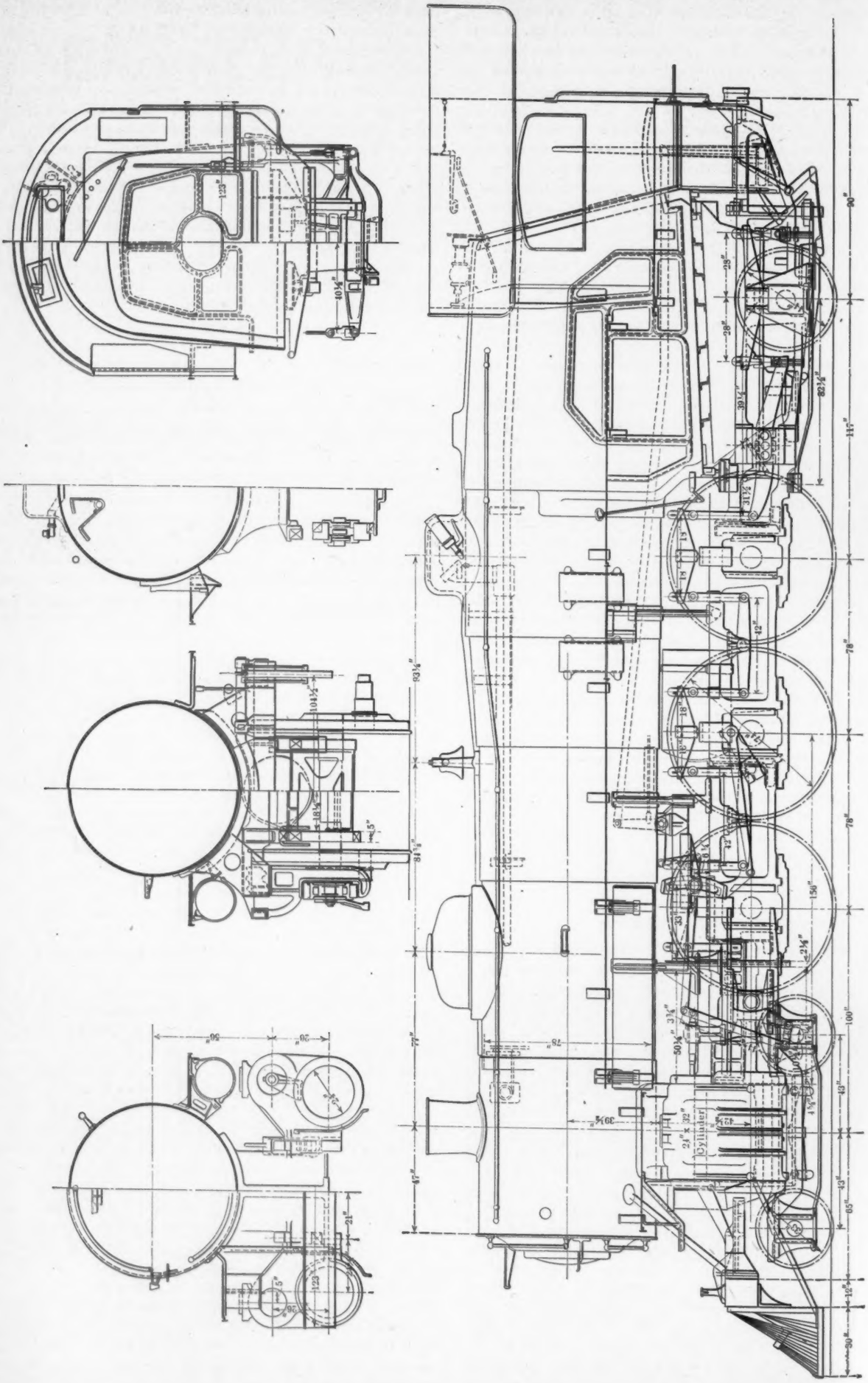
THE NEGLECTED BOILER SHOP

It is a rather singular fact that the development of the boiler shop has not been in keeping with its activity so characteristic in connection with other departments, and in many quarters a crying need for reform is strictly in order. Boiler shops can be found on roads even of considerable size that are equipped in a very inferior manner. Some of these are shops merely in name, and it is really astonishing that the repair work can be kept up at all with the limited facilities at hand. For instance, they may have but one power machine, and that of only moderate size, for punching and shearing; one or two drill presses in doubtful order, and one or two small bending rolls, together with the forges, etc.

This is a very inferior equipment for a boiler shop in which to handle any railroad work, even if nothing but repairs are done. It is impossible to do all the repairs in such a shop that may be necessary; or, at least, not possible to do them in an economical manner. On the other hand, an equipment sufficient to handle a fair amount of work at an economical figure should be supplied with tools somewhat as follows: A hydraulic riveting machine, if much new work is to be done, a large power punching machine, a large power shearing machine, large power plate bending rolls, a tube sheet boring machine, a power flue-welder, drill presses, small shears, forges, etc. In other words, the boiler shop should be placed on an equal footing with the others, and it needs a mere glance through about half of the locomotive terminals in this country to make it plain that it is not.

No sufficient reason can be assigned for this neglect, and it certainly is one which costs money in labor arising from slow operations. We have in mind on a large eastern railroad, a shop not a great way from New York, where flues are swaged down for ferrules by driving a die on the end by sledges. It requires three days' work for two men to so treat, say, 335 flues composing a set, where they might be done at the rate of one per minute by the application of suitable dies to a welding machine.

In regard to the small tools for boiler shop use, such as drills, reamers, taps, punches, chisels, etc., there should be an ample supply in every shop. They should be kept in systematic order in a tool room adjoining the boiler shop, and with strict regulations in regard to their use and return to the tool room. They should not be located in the general tool room which is generally a part of, or an annex to, the machine shop, where a walk of half a mile becomes in order to get them, with, of course, the accompanying feature of so much lost time. Although the fact may have largely escaped notice, it is not very difficult to criticise boiler shop facilities in general, and it is now about time that this important department be accorded the attention to which it is entitled, and which is so liberally bestowed on other shops possibly far less vital to the success of the general scheme.



NEW DESIGN OF POWERFUL PASSENGER LOCOMOTIVE ON THE BALTIMORE AND OHIO RAILROAD.

Powerful Freight and Passenger Locomotives

THE BALDWIN LOCOMOTIVE WORKS HAS RECENTLY DELIVERED FORTY FREIGHT LOCOMOTIVES AND TEN PASSENGER LOCOMOTIVES TO THE BALTIMORE & OHIO RAILROAD, WHICH ARE EXCEPTIONAL IN THE NUMBER OF PARTS THAT ARE COMMON TO BOTH DESIGNS.

Take a very large and powerful Pacific type locomotive designed for the heaviest class of high speed traffic and remove the driving and truck wheels, the main and front frames, rods and valve gear. Press off the wheels and replace them with centers 10 in. less in diameter, provide another pair of driving wheels of the same kind, and new main and front frames with four pedestals instead of three, provide a two-wheel engine truck, new rods, equalizers and valve gear to suit, using the same driving boxes, shoes and wedges and springs, as far as they will go, providing the duplicates for the extra wheel, and you have a locomotive of the Mikado type which will be found to be thoroughly satisfactory as a powerful freight locomotive.

PACIFIC TYPE LOCOMOTIVE HAVING MANY DUPLICATE PARTS WITH THE MIKADO TYPE SHOWN BELOW

This practically is what the Baltimore & Ohio Railroad has done in a recent order of 50 locomotives, of which ten are Pacific types and 40 Mikado types. On the two classes the boilers, cylinders, cabs, trailer truck, piston rods and cross head, valves, all boiler and firebox attachments and parts are in duplicate. This duplication extends even to springs, driving boxes, shoes and wedges, frame cross ties, cab fittings and tenders. Many of these parts are of course also standard to other locomotives already in service, making the advantage of interchangeability even greater. A study of the two designs, as shown by the general specifications at the end of this article, indicate that both classes are entirely suited for the service to be performed.

The passenger locomotives are among the largest of the Pacific type ever built. They have 24 by 32 in. cylinders, a steam pressure of 205 lbs. and with 74 in. drivers develop a tractive effort of 43,400 lbs. The total weight is 263,800 lbs., placing them among the heaviest of this type ever constructed. The Mikado type, with 64 in. drivers, the same cylinders and steam pressure, gives a tractive effort of 50,200 lbs. and weighs 274,600 lbs., being the heaviest of the type on our records.

Under present conditions it makes no difference whether a locomotive is in freight or passenger service, it is the steam making capacity that is the most vital feature in determining the success of the design. There is no reason why a boiler that is suited for a high speed heavy service Pacific type, which it is fair to assume will be of the maximum evaporative capacity possible for the weight, will not be equally well suited to a moderate speed freight locomotive. In this case the boilers are 78 in. in diameter, of the extended wagon top type and have 389 2¼ in. tubes, 21 ft. in length. This gives a tube heating surface of 4,789 sq. ft., or altogether with 228 sq. ft. in the firebox gives a total of 5,017 sq. ft., or 300 sq. ft. of heating surface for each cubic foot of cylinder volume. While this ratio is not as large as is sometimes provided for Pacific type locomotives it is larger than is customary on freight engines and is well within good practice for passenger service. The boilers are well designed along conservative lines and contain few novelties. Surge plates have been placed in the boiler barrel at the water level, one immediately in front of the firebox and the other about 7 ft. back of the front tube sheet. The injectors, as is the practice on this system, are placed on the back head and discharge into an internal pipe, which delivers the feed water near

MIKADO TYPE LOCOMOTIVE HAVING SAME BOILER, CYLINDERS, TRAILER, DRIVING BOXES, SPRINGS, CAB AND MANY OTHER PARTS AS PACIFIC TYPE SHOWN ABOVE.

the front end of the barrel. The mud rings are 5 in. in width on all sides, and the water legs have a very slight increase in width as they rise, both sheets, however, being inclined inward from the mud ring. Inside admission piston valves, 14 in. in diameter, are provided, the centers located 5 in. outside of the cylinder centers. The cylinders are cast in pairs with the saddle in the customary manner and are arranged for double front frames, the rails being 5 in. in width, the fastening being made by 1¼ in. bolts. They are keyed to the frames at the front only.

Nothing unusual is provided in the frame construction. The main and trailer frames are separate, the former being 5 in. in width and the latter 3½ in. Rigid vertical cast steel braces are provided at the main and rear pedestals and a lighter frame brace at the front pedestals in both types.

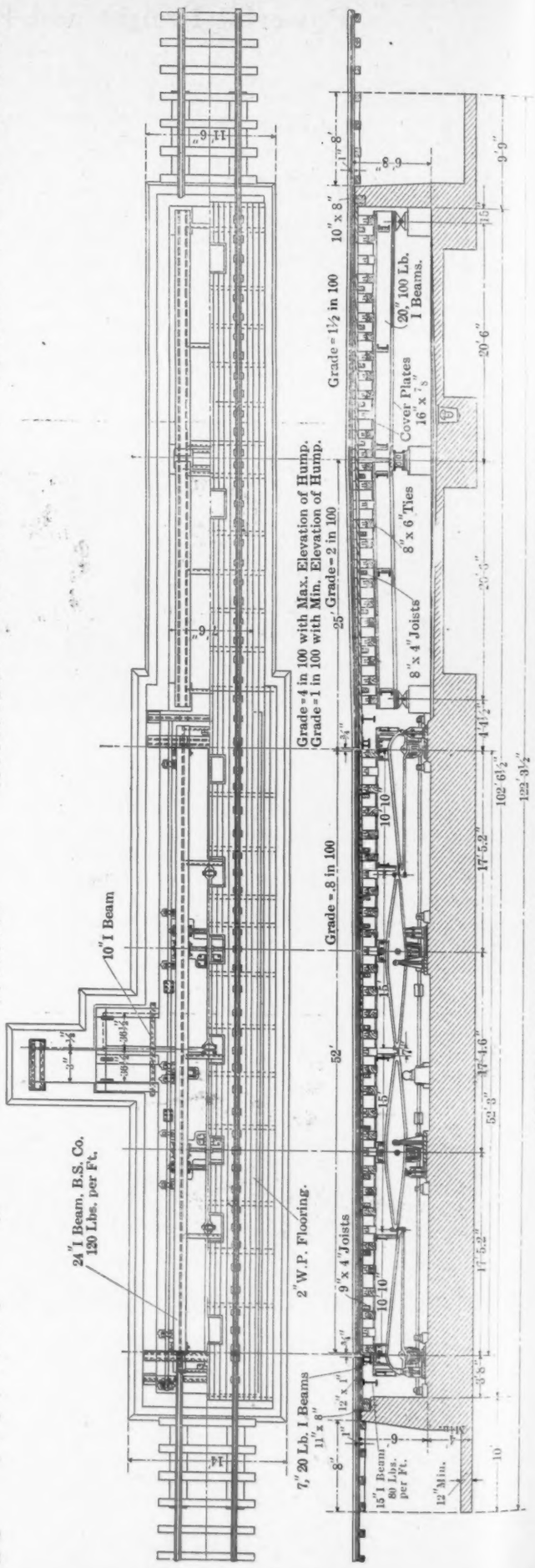
The Hodges type trailer truck with outside journals is used on both engines, the design being in duplicate. The feature of this truck as used in the present instance is a centering spring consisting of eight plates each 4 in. by ⅜ in. placed in a vertical position and secured in the center to a frame casting at the top and by a clamp to the trailer truck frame at the bottom.

The general dimensions of both designs are given in the following table:

GENERAL DATA.		
Type	4-6-2	2-8-2
Gauge	4 ft. 8½ in.	
Service	Pass.	Freight
Fuel	Bit. Coal	
Tractive effort	43,400 lbs.	50,200 lbs.
Weight in working order	263,800 lbs.	274,600 lbs.
Weight on drivers	166,200 lbs.	219,000 lbs.
Weight on leading truck	52,400 lbs.	19,500 lbs.
Weight on trailing truck	45,200 lbs.	36,100 lbs.
Wt. of engine and tender in working order	440,000 lbs.	450,000 lbs.
Wheel base, driving	13 ft.	16 ft. 9 in.
Wheel base, total	34 ft. 8 in.	35 ft.
Wheel base, engine and tender	70 ft. 10⅝ in.	71 ft. 2⅝ in.
RATIOS.		
Weight on drivers ÷ tractive effort	3.83	4.37
Total weight ÷ tractive effort	6.08	5.47
Tractive effort × diam. drivers ÷ heating surface	641.00	641.00
Total heating surface ÷ grate area	71.80	71.80
Firebox heating surface ÷ total heating surface, %	4.56	4.56
Weight on drivers ÷ total heating surface	33.10	43.80
Total weight ÷ total heating surface	52.60	54.80
Volume both cylinders, cu. ft.	16.80	16.80
Total heating surface ÷ vol. cylinders	300.00	300.00
Grate area ÷ vol. cylinders	4.17	4.17
CYLINDERS.		
Kind	Simple	
Diameter and stroke	24 x 32 in.	
VALVES.		
Kind	Piston	
Diameter	14 in.	
WHEELS.		
Driving diameter over tires	74 in.	64 in.
Driving thickness of tires	4 in.	4 in.
Driving journals, main, diameter and length	11 x 13 in.	11 x 13 in.
Driving journals others diameter and length	9½ x 13 in.	9½ x 13 in.
Engine truck wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ x 12 in.	6 x 10 in.
Trailing truck wheels, diameter	44 in.	44 in.
Trailing truck, journals	8 x 14 in.	8 x 14 in.
BOILER.		
Style	Ext. W. T.	
Working pressure	205 lbs.	
Outside diameter of first ring	78 in.	
Firebox, length and width	120 x 84 in.	
Firebox plates, thickness	⅜ & ½ in.	
Firebox, water space	5 in.	
Tubes, number and outside diameter	389—2¼ in.	
Tubes, length	21 ft.	
Heating surface, tubes	4,789 sq. ft.	
Heating surface, firebox	228 sq. ft.	
Heating surface, total	5,017 sq. ft.	
Grate area	70 sq. ft.	
TENDER.		
Frame	15 & 10 in. chan.	
Wheels, diameter	36 in.	33 in.
Journals, diameter and length	6 x 11 in.	
Water capacity	9,500 gals.	
Coal capacity	16 tons	

To PROVIDE ADDITIONAL FACILITIES for handling traffic on its Indianapolis Division, the Pennsylvania Lines are making extensive improvements by constructing 25.9 miles of second track. Some idea of the magnitude of the work which has been undertaken is seen in the figures showing that no less than twenty-five street and highway and two railroad grade crossings are to be eliminated. This alone will entail the building of four overhead and sixteen undergrade crossings and the vacation of five highways, formerly crossing the railroad at grade.

AT THE RECENT BRUSSELS EXHIBITION there was not a single British locomotive, despite the fact that the British government assisted exhibitors to send exhibits.


Grade = 1½ in 100
10" x 8"
20" 100 Lb. I Beams.
Cover Plates 16" x ⅞"
8" x 6" Ties
8" x 4" Joists
Grade = 4 in 100 with Max. Elevation of Hump.
Grade = 1 in 100 with Min. Elevation of Hump.
Grade = 2 in 100
Grade = .8 in 100
10" I Beam
24" I Beam, B.S. Co. 120 Lbs. per Ft.
2" W.P. Flooring.
9" x 4" Joists
7", 20 Lb. I Beams
11" x 8"
15" I Beam 80 Lbs. per Ft.
12" Min.
FIFTY-TWO FOOT TRACK SCALES WITH MECHANICAL HUMP— PENNSYLVANIA RAILROAD.

A NEW DESIGN 52-FOOT TRACK SCALE WITH MECHANICAL HUMP.

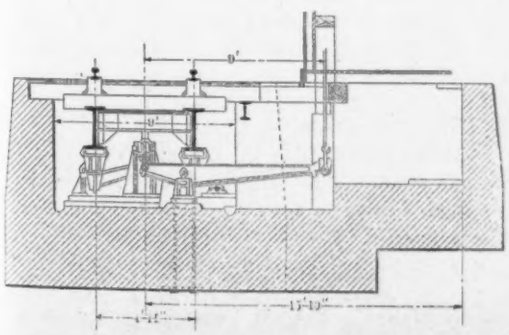
PENNSYLVANIA RAILROAD.

At West Brownsville Junction, Pa., the Pennsylvania Railroad have recently built a new 52-foot track scale which incorporates a number of important improvements and interesting details. With the scale has also been constructed a mechanical hump, which, for a distance of 25 ft. from one end of the scale platform, can be given an inclination varying between 1 and 4 per cent. grade as desired. This scale is provided with a mechanical relieving gear, doing away with the customary dead track, and is arranged so that the platform is independent of the weighing mechanism, thus eliminating the effect of snow and ice, wind pressure, or dirt on the empty balance of the scale.

It will be noticed by reference to the illustration that all wooden substructure has been eliminated and a most substantial

VIEW SHOWING SUBSTANTIAL FOUNDATIONS.

concrete foundation is provided for all parts. Tipping of the platform and the overhang at the ends have been avoided and all vital parts of the mechanism are easily accessible. It is of the four-section type, since with this arrangement there are no idle connecting levers required with their additional fulcrum points and friction. A new type of main bearing has been employed, which gives greater freedom of action to the weighing platform and eliminates the gyration of the knife edges across the face of the hardened steel. These bearings are of the suspension type, wherein two links, suspended from the main lever knife points, support a yoke casting bolted to the eye-beams



CROSS SECTION OF FIFTH LEVER.

forming the bridge tnat supports the scale rails. All of the main lever stands and extension lever stands supported from the four main bed plates are provided with self-compensating

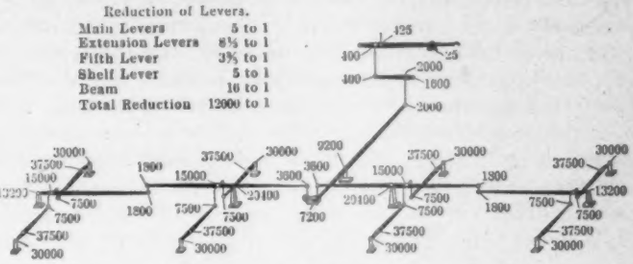
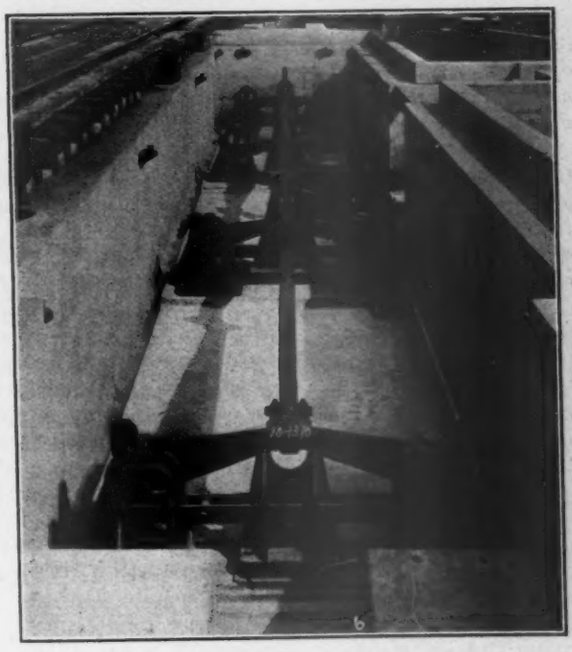


Diagram showing Loads on Lever System.

steels wherever a pivot contact is made and means are provided for maintaining an independent alignment of each knife lever. Leveling pads are also provided on all levers with faces machined in the same plane with the neutral axis.

A maximum load of about 4,000 lbs. is provided for each lineal inch of knife edge at any point. All of the friction as well as contact points throughout the scale are made of a special mixture of vanadium steel which, it is believed, will be less susceptible to corrosion and will give a longer life.

Probably the most radical departure from the usual form of construction is the introduction of relieving gear, which takes the place of the usual rigid dead rail system with supporting columns that practically fill the vault and prevent proper inspection and maintenance of the bearings. It also eliminates the approach and switches at either end. This relieving gear



VIEW SHOWING LEVERS AND RELIEVING GEAR IN PLACE.

consists of a series of eight toggle lever jacks supported in pairs by the universal bed plates. These jacks are operated through suitable link connections from a shaft which in turn is operated by a double-ended cylinder, using either air or water for power, the controlling valves being in the scale office. The mechanism can also be operated by hand if necessary. When these jacks are put in operation they raise the platform to a position of repose, taking all weight from the knife edges, but do not lift the knife edges from their seats. There is a semaphore at either end of the scale connected to the bearing shaft, which indicate whether the scale is out or in. While these jacks will support the largest consolidation locomotives without showing any weight on the beam while it is going over the scale, the relieving gear cannot be operated while the scale is under load, but since the aver-

age interval between cuts of cars is 18.6 seconds and the relieving gear can be operated in 1 second, it is not felt that this is necessary.

The object of the mechanical hump is to provide simple and effective means whereby, with a minimum of attendance for manipulating the cars, they can be passed rapidly and without stoppage over the platform to the scale with the proper velocity to permit each car to be weighed as it passes over the scale platform regardless of the variation in length of successive cars. For this purpose the 50 ft. of track just above the scale is supported in 25 ft. sections on large 20-in. I-beams, supported at the ends on pivotal castings and at the center by common rigid steel castings, one on either side, which in turn are supported by abutments to which the bed plates are bolted. These same

GEAR FOR ADJUSTING HEIGHT OF MECHANICAL HUMP.

abutments also support, directly under a vertical center line through the rail, two toggle lever jacks of the Sampson screw type, which are connected by an extension socket and are operated by a hand ratchet with a lever arm in the center. When the toggle jacks are set to give the required elevation, liners are inserted under the center castings and the jacks are relieved. Means are provided for taking care of the change in length of rail, due to a raised or lowered apex or to expansion or contraction from atmospheric conditions, by the insertion of bronze friction plates at the base of the four pivoted castings at either end of the hump, thus allowing them free change of position in a longitudinal direction.

The vault of both the scale and the hump are heated by a hot water circulating system and are provided with electric lights, permitting an easy and thorough inspection at any time.

Most of the features of this scale are covered by patents issued to A. W. Epwright, scale inspector of the Pennsylvania Railroad.

HIGH POWER LOCOMOTIVE HEADLIGHTS

During the past year considerable discussion has taken place in regard to the use of locomotive headlights of high candle-power. In seven states, Arkansas, Montana, North Carolina, Oklahoma, South Dakota, Texas and Washington, locomotive headlights of 1,500 candle-power or over are required by law; in Indiana, locomotive headlights of 1,500 candle-power or over are required by an order of the State railroad commission and in Georgia the law requires electric headlights with 300 watts at arc end reflectors 23 inches in diameter.

The ordinary oil headlight commonly employed on locomotives is seldom powerful enough or maintained in a condition to make it more than a marker to indicate to persons at stations or railway crossings, or in yards or to trains on other tracks, that an engine is approaching. As a means of discovering or identifying distant objects on the track it has practically no value. The argument in favor of the high-power headlight is that persons or obstructions on the track may be seen by the light of a powerful gas or electric headlight at a sufficient distance to enable the train to be stopped before reaching them. On straight track the high-power headlight undoubtedly affords a degree of illumination, except in snow or fog, sufficient to enable an experienced engineman to distinguish unusual objects on the track at a considerable distance.

As headlights are usually fixed in position, their rays are projected in the direction of the axis of the locomotive, and hence on curves do not illuminate the track ahead. Various devices have been submitted to the board intended to impart to the headlight, while the engine is rounding a curve, motion to turn its beam so that it will fall on the track. Most of these devices are crude, and attempt to use the curving of the front truck of the locomotive as it passes around curved track to rotate the headlight. It seems unlikely that any apparatus of this kind can be made effective to meet all the conditions of reversed curves, tangents succeeding curves and variations in curvature, that are found on many railroads, and it is probable that if full advantage is to be taken of the high illuminating power of gas or electric headlights on roads where much curvature exists, any motion of the headlight about its vertical axis must be within the control of the engineman.

Very strong objections are made to the use of high-power headlights, for the reason that the rays are so intense as to impair seriously for several seconds the vision of persons who may look into the beam. This effect, when experienced by enginemen of trains running in the opposite direction on parallel tracks, is considered by many to be serious. It has long been known that after a locomotive fireman has looked into the fire box for even a very few seconds in putting on coal the scotoma which persists for some seconds afterwards, makes his reading of signals at night very unreliable until its effect has had time to pass off.

As regards the effect of the high-power beam upon the vision of the men riding on the engine on which the electric headlight is used, it has been found in some rather extensive tests that the rays were sufficiently powerful to reflect back from the surfaces of the roundels of semaphore signals an amount of light sufficient to overpower the light transmitted by the signal lamps themselves. The spectrum of the electric arc is very rich in blue and green rays and contains a relatively small proportion of the red and yellow; hence rays from the arc light reflected from the surface of the colored roundel would tend to diminish the resultant proportion of red in the light, and if reflected back from a green roundel would intensify its color. Very deceptive effects of this kind have been noticed by many observers, and while apparently such conditions may be dangerous as leading to erroneous reading of a signal light, they are largely counteracted by the fact that the high power of the light serves to reveal at a considerable distance the position of the signal arm. The usual rules governing enginemen in their interpretation of signal indications state that the indications will be displayed by day by positions of the semaphore arm, and in addition at night by lights of prescribed color, the effort being made to train the enginemen in so far as possible to depend upon position rather than upon color.—*From report of the Block Signal and Train Control Board.*

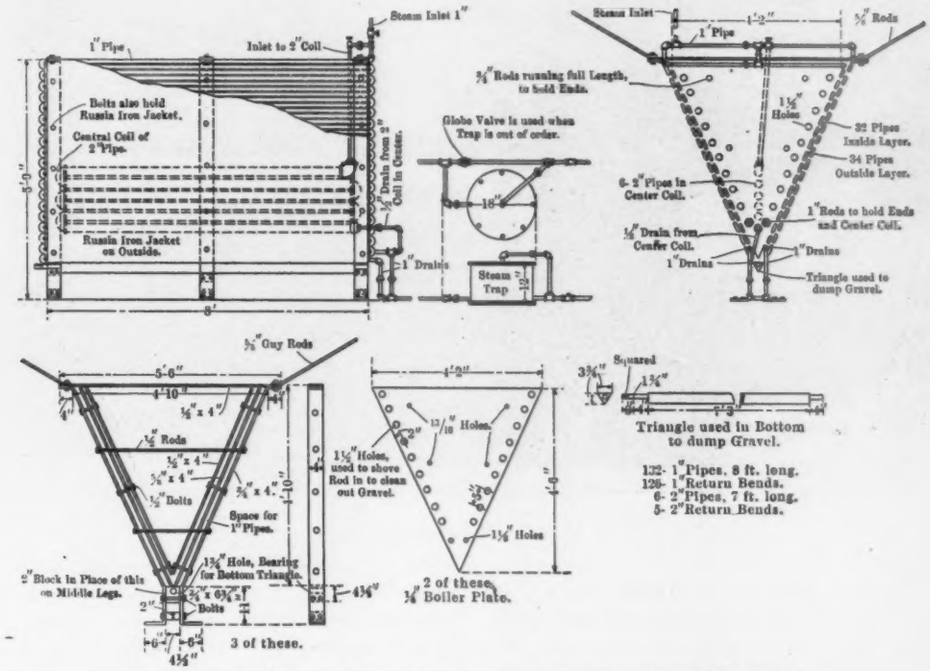
ALL WIRE ROPES USED IN OUTSIDE OPERATIONS suffer more or less from oxidation or rusting, and wire ropes running underground are frequently subjected to the corroding influence of water containing acids, which is still more destructive; and it is very necessary, therefore, that such ropes should be properly coated with some suitable material. For ropes subjected only to atmospheric conditions, a good quality of boiled linseed oil, or pine tar thinned with turpentine, will answer the purpose; but for ropes coming in contact with water, and especially with water containing acids, some of the preparations of crude petroleum, or a mixture of this with graphite, should be used.

BEESWAX MAKES A PERFECT LUBRICANT when cutting threads in copper. The wax is merely rubbed into the threads.

A CHEAP AND EFFECTIVE SAND DRYER

CHICAGO AND NORTH WESTERN RAILWAY.

There are probably at least five hundred different designs of sand dryers in use in this country, and the assertion is fairly safe that the next decade will witness as many more. One peculiarity in connection with this device is that comparatively few railroads have standardized their sand stoves, leaving the design of the latter to the ingenuity of the various master mechanics. Hence the schemes for sand drying range from a simple bed of steam pipes, on which the sand is laid, to most


Steam Inlet 1"
1" Pipe
Inlet to 2" Coil
Bolts also hold Russia Iron Jacket.
Central Coil of 2" Pipe.
Russia Iron Jacket on Outside.
1" Drains
Globe Valve is used when Trap is out of order.
Steam Trap
Steam Inlet
1" Pipe
1'-2"
⅝" Rods
¾" Rods running full Length, to hold Ends.
1½" Holes
32 Pipes Inside Layer.
34 Pipes Outside Layer.
6-2" Pipes in Center Coil.
1" Rods to hold Ends and Center Coil.
1" Drains
Triangle used to dump Gravel.
⅝" Guy Rods
5'-6"
4'-10"
½" Rods
Space for 1" Pipes.
1¾" Hole, Bearing for Bottom Triangle.
2" Block in Place of this on Middle Legs.
Bolts
3 of these.
1½" Holes, used to shove Rod in to clean out Gravel.
1⅛" Holes
2 of these, ¼" Boiler Plate.
Squared
Triangle used in Bottom to dump Gravel.
132- 1" Pipes, 8 ft. long.
126- 1" Return Bends.
6- 2" Pipes, 7 ft. long.
5- 2" Return Bends.

DETAILS OF SAND DRYER—CHICAGO AND NORTHWESTERN RAILWAY.

elaborate contrivances, but in the long run, so far as securing the purpose for which intended, there is little to choose from between any of them.

The sand dryer illustrated herewith is the latest addition to a formidable collection of similar devices. It embodies the novelty of being constructed entirely of pipe, and will no doubt be of interest where the installation of sand drying facilities is in contemplation. One and two inch pipe is used, and the detail drawing clearly indicates the manner in which it is run. This pipe constitutes the heating surface, and the area of the latter combined with the capacity of the dryer is sufficient to take care of the needs of a large terminal, for instance, one handling one hundred engines in twenty-four hours. At the bottom of the dryer is a triangular piece of iron which is held on bearings at either end. One of these ends is squared for the reception of a wrench which allows it to be turned so that the gravel can be dropped out. To further facilitate this operation the ¼ in. boiler plate which encloses the ends of the dryer is perforated with a number of 1½ in. holes through which a rod can be inserted to start the gravel down. The sides of the dryer are enclosed by Russia iron boiler jacket bolted to suitable wrought iron strip.

The device appears to be thoroughly practical, and is certainly inexpensive. It has been in use at the Clinton roundhouse of the Chicago and Northwestern Railway for a number of years, and is said to have given perfect satisfaction.

IN THE LAST THREE YEARS 840 LOCOMOTIVES have been withdrawn from service on the Russian State railways, and it has been decided to fix the maximum life of a locomotive at 25 years for the future.

ASBESTOS SHINGLES AND SHEATHING FOR FIREPROOFING RAILROAD BUILDINGS

The application of asbestos to secure fireproofing for the various classes of railway buildings is being accorded considerable attention at present as is evinced by several recent structures wherein its use is embodied. An installation of this product which should prove of particular value may be found at the New Durham shop of the New York Central Railroad, where seventeen single and five double roundhouse smoke jacks have been included in connection with the new plant under construction. These asbestos lumber smoke jacks as distributed by the Franklin Mfg. Co. are absolutely fireproof; are not subject to deterioration and corrosion, and being very light in construction a great saving can be effected in roofing timbers.

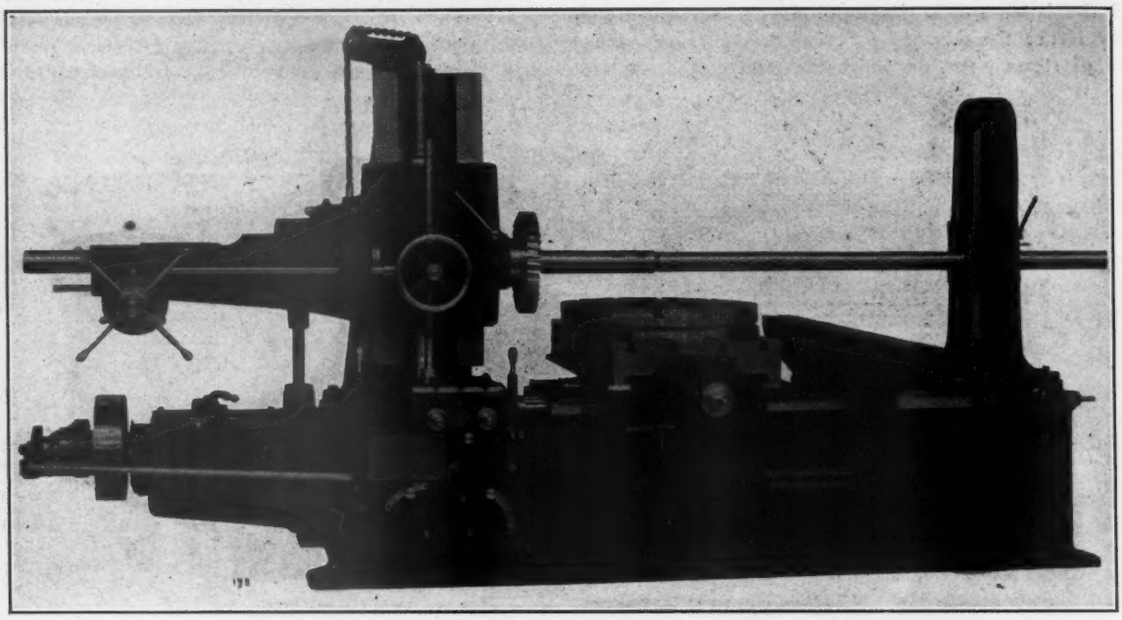
In the matter of fireproof construction there is probably no material on the market which is being more generally considered than the asbestos corrugated sheathing and asbestos shingles. These materials are an asbestos concrete production made under hydraulic pressure, and the action of the atmosphere on the cement vitrifies the materials and preserves them for an indefinite period. They are impervious to the action of sulphurous gases and acids and the fumes prevalent around railroad shops and buildings, and once applied they require no cost for maintenance. The asbestos corrugated sheathing may possibly come a trifle higher than the best grades of corrugated iron, in first cost, but when the life of the material is considered, and the fact that the asbestos corrugated requires no paint or other cost for maintenance, it is much cheaper in the long run.

NO PLATFORM GATES AT THE BOSTON SOUTH STATION.—In striking contrast to the barriers interposed at the platform entrances in the majority of great terminals is the utter disuse of gates in the Boston South Terminal station of the New York, New Haven and Hartford Railroad. Despite the lack of these adjuncts, however, it should be remembered that the South Station operates 876 daily passenger trains, on summer schedules, and handles about 20,000,000 people per year without the slightest inconvenience. A remarkable fact in connection with this departure from time-honored observance is that no one abuses the privilege, and the platforms are always clear for incoming and departing passengers.

NEW DESIGN HORIZONTAL BORING MACHINE WITH SPECIAL FEATURES

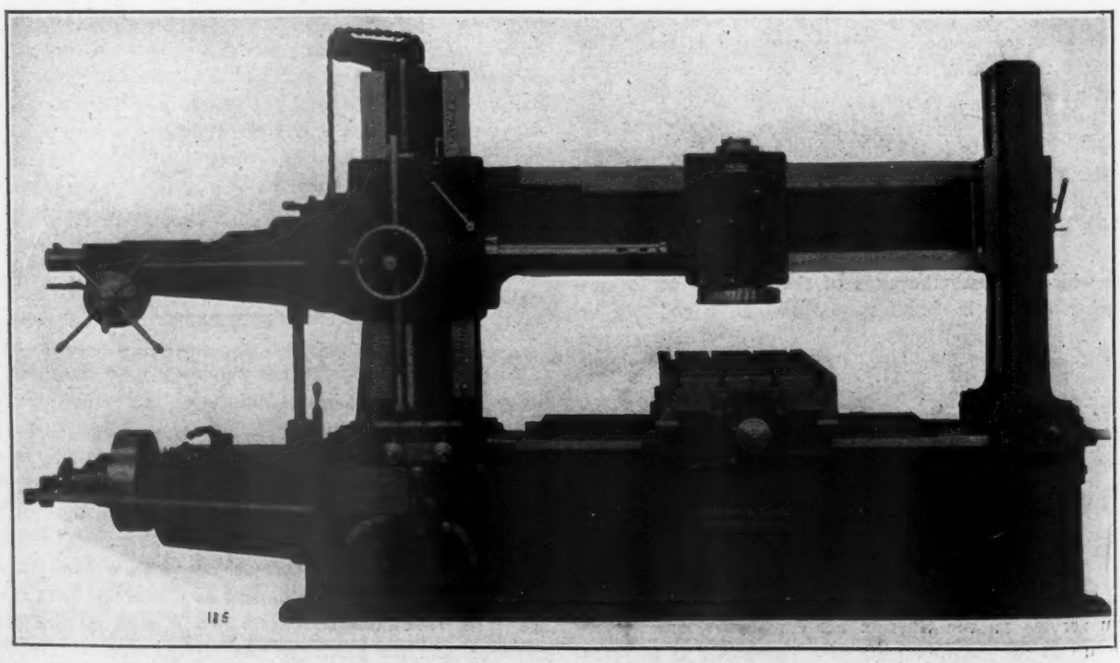
The latest output in horizontal boring mills by the Lucas Machine Tool Co., of Cleveland, O., is the successful result of many patient years of work and experiments by the designers to secure the highest possible development in this particular tool. Previous to the year 1900 the horizontal boring mill was considered very largely in the light of a necessary evil. It is no doubt well remembered that its imperfect design made it practically impossible to bore holes parallel, or an exact distance apart, and as it was incapable of doing any class of work except boring and drilling, it was often idle and was unpopular accordingly.

Some years ago, however, the Lucas Machine Tool Co., having recognized the inherent possibilities of such a machine, determined to take advantage of the situation, and work toward the production of a machine of broader usefulness. It is to this that they have given the name "Precision," in which the old type of knee construction is reversed, milling feeds and power movements included without complication, and resulting in a permissible range of work so wide that it would be undreamed of in the old days. The machine in its present form is the result of ten years of development and improvement. A proper distribution of metal insures strength, and the parts most subject to strain are amply proportioned to stand severe service. Simplicity of construction has been kept in mind, and all complication studiously avoided. The unusual accuracy of the tool insures that all the different cuts taken are true with each other, and serves largely to account for its extensive use in shops where the best quality of production is a necessity.

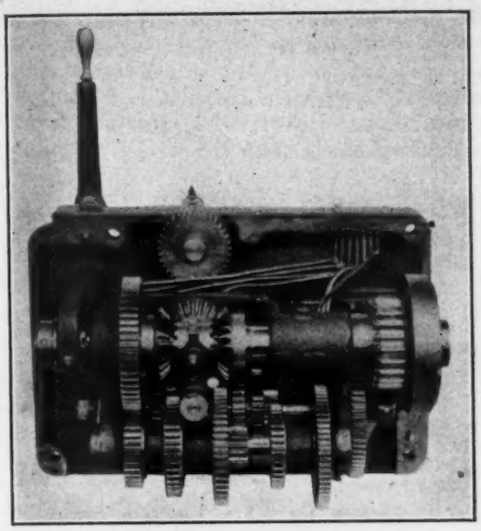


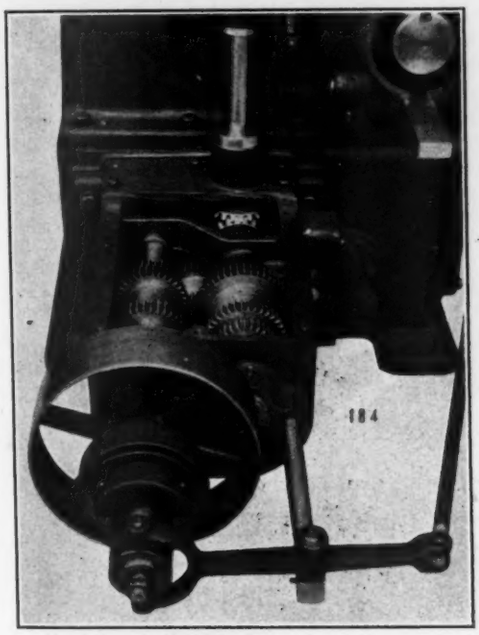
THE NO. 32 LUCAS PRECISION BORING MACHINE.

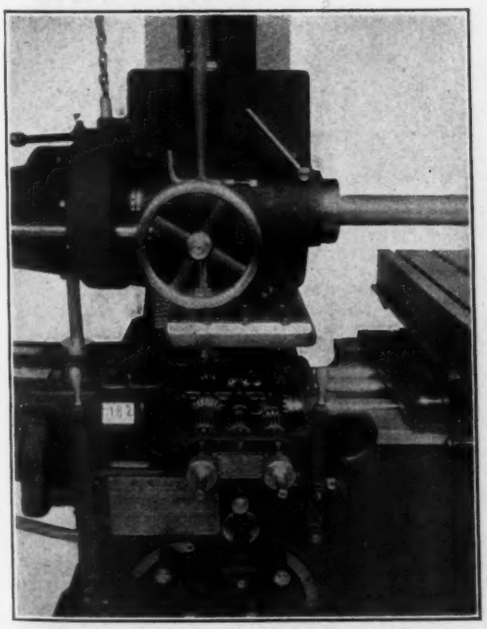
The principal feature of the No. 32 machine, herein illustrated, which differs from former machines, is that it has constant speed quick power movements to all parts having feeds and this is so arranged that no matter what feed is used, the quick return for that feed is obtained by simply moving the feed



BORING MACHINE EQUIPPED FOR SURFACE MILLING.







THE FEED, SPEED AND DISTRIBUTING BOXES.

engaging lever in the reverse direction. This lever is shown in the photograph just above the feed levers, and to the right of the gear box on top of the bed. When it is in the left-hand position it gives a quick vertical movement to the head, a quick cross movement to the platen, or a quick longitudinal movement to the saddle or to the spindle, depending upon the position of the interlocking levers on the cover of the gear box on top of the bed. When the feed engaging lever is in the right-hand position, the corresponding feeds are obtained.

The feed is operated by two levers controlling sliding gears and giving nine changes for either position of the spindle back gears, which gives a total of eighteen changes ranging from .004 in. to .600 in. per revolution of the spindle. These feeds may be applied to the spindle, spindle head and tail block, saddle and platen; they are so arranged that not more than one feed can be engaged at the same time, and it is also impossible to use the power movement when any feed is engaged, or to engage any feed when the power movement is in use. All feed screws are true to pitch, and are provided with dials graduated to read to thousandths of an inch, which allows the work to be done accurately and interchangeable parts produced without the use of jigs. The machine may be driven by belt or by a direct connected motor. If by belt, the speed should be such as to drive the 16 in. pulley on the machine 300 r. p. m.; if electrically driven, a 7½ h. p. constant speed motor running at 1,000 to 1,200 r. p. m. should be used. These speeds give the spindle a range of from 7½ to 150 r. p. m. The machine will take work 6 ft. long between the face plate and the outer support, and has a 36 in. cross feed provided with an automatic trip.

The foundation principle of this machine, in common with all those of the "Lucas Type," is raising and lowering the spindle head, which is a constant weight instead of raising and lowering the table with its load, which is widely variable. This construction allows the use of a deep bed of great stiffness, which gives a solid foundation to the other members of the machine, and keeps them in accurate relation to each other in all positions. The bed is of complete box section, well ribbed, and with a continuous bottom, the strongest form in which the metal can be distributed. As a result the machine is thoroughly self-contained and can be satisfactorily operated without building a foundation under it. This permits it to be moved from one part of the shop to another as changes in conditions demand The top of the bed is protected by guards, which are so designed that they make convenient tool pans.

The backrest which carries the tail block is symmetrical in design, of complete box section and has a base with liberal bearings on the bed. To accommodate long work, the backrest can be taken from its base simply by removing four screws, without disturbing any other mechanism, and without impairing the general rigidity of the machine. The base can be adjusted along the bed by means of a wrench operating a pinion meshing with the saddle adjusting screw, which in this instance serves as a rack. The base is gibbed to the bed and has a clamping screw to secure it in any desired position. The tail block has long "V" bearings, which makes it impossible for the backrest to spread, with the result that when the tail block and backrest are bound together, they become practically one piece.

The spindle head and tail block are raised and lowered together, being connected by a shaft and planed bevel gears. The spindle is of hammered crucible steel, accurately ground its entire length, and cannot be lowered far enough to come in contact with the top of the platen. It does not revolve in boxes, but slides through a sleeve. This latter is of a solid high carbon steel forging; it has a conical journal at the front, revolving in a solid bronze box, and a cylindrical journal at the rear revolving in an adjustable bronze box. The spindle drive is transmitted in the most direct manner possible from the source of power to a gear of large diameter on the spindle sleeve. The back gears are on the head, which is the proper place for them, and are engaged and disengaged by a convenient lever.

Another photograph shows this machine arranged as a Vertical Milling Machine by means of a cross rail bolted to the

head carrying the horizontal spindle and the outer support. On this cross rail slides the head carrying the vertical spindle which is fed along the rail either by hand through the rack and pinion movement or by the power traverse to the boring bar and all vertical adjustments can be made either by hand or by power as may be desired. The vertical spindle is constructed along the same lines as the horizontal spindle, which is of forged steel, and has a large taper front bearing as in modern milling machine construction. This runs in a solid bronze bushing in the solid head of the machine with a collar between the shoulder, on the end of the spindle, and the end of the bronze bushing. This makes a very solid construction, and a very slight reduction in the thickness of this collar allows for any adjustment that may be necessary after long use. The rear bearing is straight, but the split bushing is taper on the outside and can be adjusted by the locking nuts shown to compensate for all wear.

Milling cutters of large diameter, like the 12 in. cutter shown, are bolted directly to the spindle flange. It will readily be seen that the combined movement of the head and platen gives this form of machine an extremely wide range for surfacing work.

A Practical Storage Battery Car

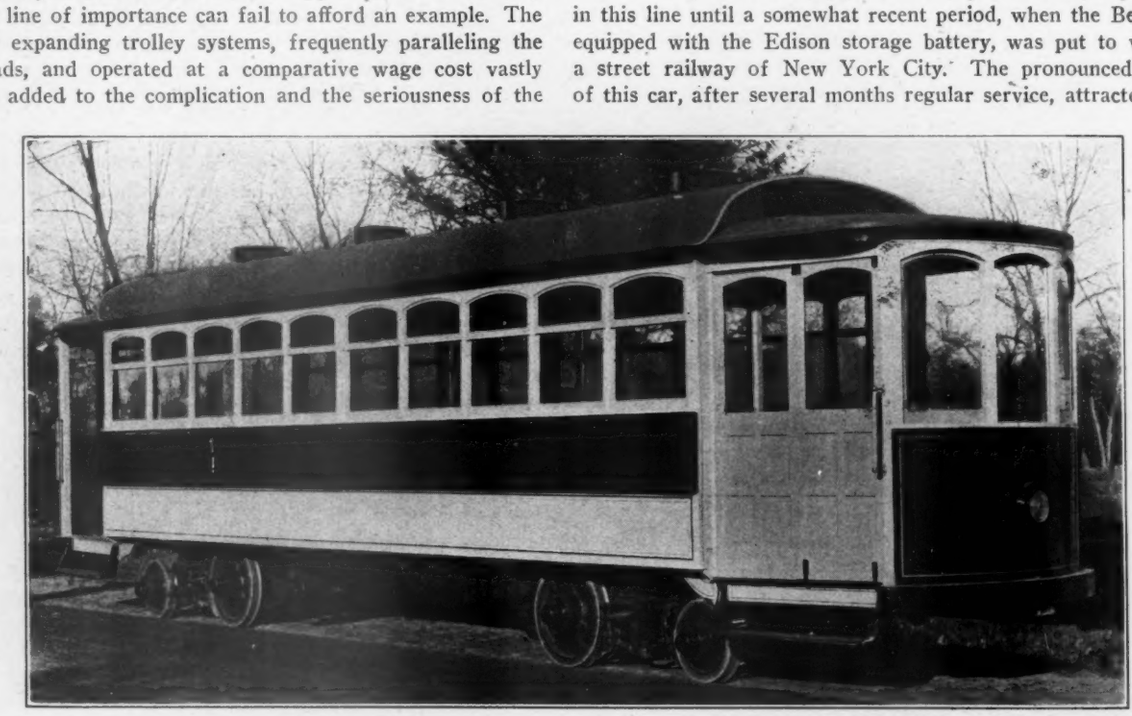
RECENT EXPERIMENTS ON THE ERIE RAILROAD WITH THE NEW BEACH CAR EQUIPPED WITH EDISON STORAGE BATTERIES INDICATE THAT A SOLUTION IS IN SIGHT TO THE PROBLEM OF PROVIDING CHEAP AND EFFICIENT TRANSPORTATION ON BRANCH LINES AND UNDER CONDITIONS WHERE THE STEAM LOCOMOTIVE IS UNECONOMICAL.

For many years the fact has been plainly apparent to motive power management in general that the steam locomotive, with the attendant expense of its own and the train crew, is no longer profitable on small branch lines or under any condition where the traffic is light and variable. Such instances are common both in this country and abroad; in fact, it may be said that scarcely any trunk line of importance can fail to afford an example. The constantly expanding trolley systems, frequently paralleling the steam roads, and operated at a comparative wage cost vastly less, have added to the complication and the seriousness of the question, until in many instances the railroads would have been practically justified in abandoning certain of these branches on which money is steadily being lost.

In the large majority of cases, however, it is found that it would be impracticable to so discontinue the service, as the branches make close connection with main line express and suburban trains, and more frequently the railroad has vital interests on the branch in question which necessitate, if they do not demand, its operation.

Various solutions to the problem have been sought in electrification, which, however, is not generally resorted to, owing to the prohibitive cost of the third rail or the trolley system, when compared with the revenue expected; by gasolene motor cars, and even light steam cars, but despite the variety of ingenuity displayed in coping with the situation, it has not by any means deterred the efforts of those who believed that the self-propelled vehicle was the most likely solution, and stored electricity the best medium.

Unsatisfactory developments in storage batteries, however, which remained prominent for many years, in connection with the application of electricity to such comparatively heavy service as demanded by the railroad, precluded any successful experiments in this line until a somewhat recent period, when the Beach car, equipped with the Edison storage battery, was put to work on a street railway of New York City. The pronounced success of this car, after several months regular service, attracted wide-



THE BEACH CAR EQUIPPED WITH EDISON STORAGE BATTERIES.

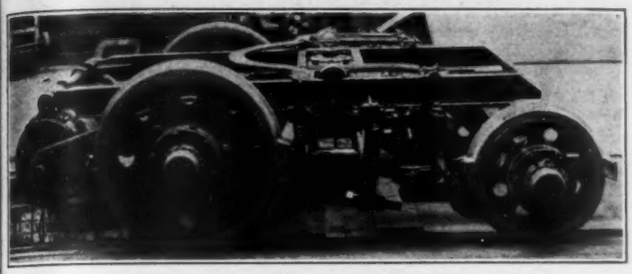
spread attention to the system, the outcome of which was the purchase of the car herein illustrated by the Erie Railroad.

Since November 14, 1910, it has been running regularly on a branch of that railroad from Forest Hill, N. J., to West Orange, N. J., a distance of somewhat over four miles, and has been easily maintaining the schedules assigned to the former steam service. This car was in reality primarily intended for street railway service, which is evinced by the very long platforms for easy entrance and exit under the pay-as-you-enter system, and it has also maximum traction trucks, better adapted to city conditions than to country running as on the branch where in service.

Nevertheless, although the car was not constructed with the requirements of the Erie under consideration, its performance for the latter has been such that much interest has been awakened, and it is believed that it will be the means of effectually

solving the vexatious problem which has been commented upon It has invariably made its runs on time, even during blizzard weather, and is felt to be fully dependable for the service by those interested.

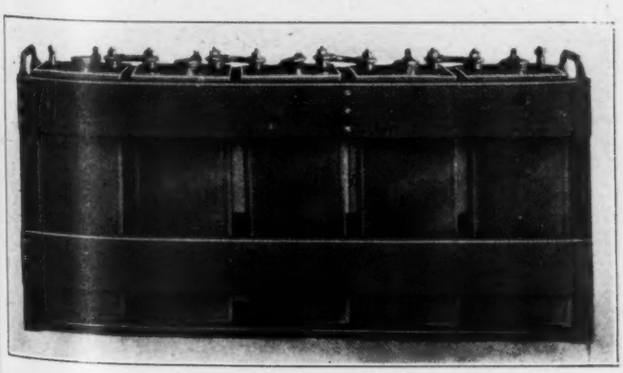
Some interesting figures are available in regard to the economical results which have been attained; for instance, on a recent test run of 48 miles from West Orange to Forest Hill, thence



MAXIMUM TRACTION TRUCK.

to Greenwood Junction, thence to Newark, and thence to Paterson and return to West Orange, the batteries were only charged one hour for the entire run. The power consumption on the 48 miles averaged 625 watt hours per car mile, or 43 watt hours per ton mile, which is about the average power consumption of the car on its regular runs between West Orange and Forest Hill. Electric current costing 2 cents per kilowatt hour would, therefore, make the power cost in this case 1¼ cents per car mile. In this special run, to test out the car over greater distances, the maximum speed attained was 32 miles per hour, and the average between stops 25 miles per hour. From the viewpoint of acceleration the car shows remarkable efficiency, as nearly as can be determined reaching its maximum speed on level and straight track in 1,000 feet.

The car herein illustrated is 28 ft. long, inside of corner posts, and 7 ft. 6 in. wide over deep rail. The platforms are 6 ft. 1½ in. long, and the overall length of the car is 40 ft. 3 in. The car is of steel channels, I beams and steel sheathing throughout, with selected white ash trim. Arched roof is used, instead of the usual monitor, or double-decked roof. The attractiveness, strength and lightness of this roof is obvious. It is formed of two eccentric arches, and is a much stronger roof than is possible in monitor form. It allows increased head room, affords by automatic ventilators in the top a uniform and adequate ventilation, and permits of the double sash and high window, not possible with the old form of roof. The roof is supported by vertical rust-proofed (in black) steel tubes, which serve also as grab rails instead of the usual strap; these vertical tubes are, in turn, supported by the longitudinal lattice steel girder, which also supports the seat and serves as a battery case and "back bone" on each side for the entire car structure. The horizontal steel



THE EDISON A8 STORAGE BATTERY.

tubes, which are enameled white, serve as conduits for the lighting cables, and supports for the lamp, bell and fare register cord fixtures.

Notwithstanding the steel construction, the entire weight, complete with 180 A8 cells of battery, is about 30,000 lbs., or about 725 lbs. of dead weight per seated passenger. Careful design, selection and distribution of materials, elimination of all useless fixtures and weight in materials, such as the arched instead of monitor deck roof, the open instead of the full bulkheads, etc., has made possible this great reduction in dead weight and still permitted a safe factor of strength.

The interior is provided with 10 c.p. lamps There is such a lamp on each platform, and lamp of larger capacity in each headlight carried in multiple arc, so that any number may be used, and their current is taken from a special set of battery cells, which are charged, however, in series with the power battery.

The truck, which is herein illustrated, is of interesting construction. It is what is known as the Maximum Traction type and in it an entirely new method of design is followed. The axles are of chrome steel I beam sections, each forged with 3¼ in. ends inserted into the bearings, which are of the "Rollway" type, and are contained in the hub of the wheel. These bearings eliminate friction to a large extent and are inexpensive to maintain. The axles do not revolve, each wheel rotating independently of the other, thereby eliminating all wheel slipping; for example, on a tangent track because of the varying diameter of all car wheels, and particularly at curves because of the inde-

INTERIOR OF STORAGE BATTERY CAR.

pendent action of each wheel. By this, instead of the old method whereby the wheels are rigid with the axle and the axle is driven, much of the friction loss is eliminated, less power is consumed, and, incidentally, rail corrugation is overcome.

As usual in maximum traction trucks, the Beach Maximum Traction truck carries the load principally on the driving or large wheels, and each driving wheel is independently driven by a 10 h.p. motor, the location of which is shown plainly in the illustration. Four such motors, provided with ball bearing journals are required for each car. They have ample capacity for the loads and speed required, have a safe factor for overloads, and are especially smooth at acceleration Oxy-acetylene welding has been resorted to throughout the truck, which contains no bolts or rivets, and in fact the somewhat novel application of this process is in evidence in several quarters in connection with the steel underframe. The provisions made for motor suspension, especially in connection with the chain drive, which can be readily maintained at the desired tautness; the details of the truck, and the spring action, are especially well worked out. Both hand and air brakes are provided in the car under consideration.

The Edison battery, as applied to Beach cars, has a mileage capacity, per single normal charge, at the normal low charging rate, and for seven hours, at from 60 to 100 miles in the single truck cars, and from 80 to 125 miles in the double truck cars, this particular car has a range per battery charge of 115 miles, using 180 A8 cells. By giving the battery short intermediate charges, or "boosts," of from 5 to 30 minutes duration each, occasionally

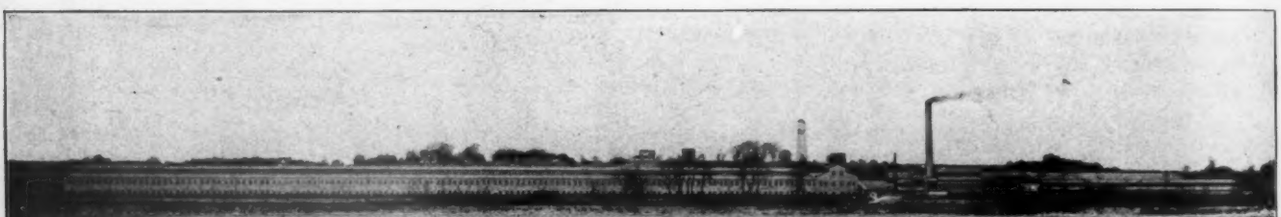
during the day's work, a much greater mileage may be obtained without damage to the battery and at a lower average power consumption. The average watt hour efficiency of the Edison battery is 61 per cent. based on the normal battery charge mentioned above. The average watt hour efficiency on the short intermediate charges or "boosts" at the high charging rate is about 98 per cent., therefore the efficiency, when operating the battery on the normal charge, together with the "boosts" occasionally, brings the average efficiency of the battery up to 80 or 85 per cent., according to the skill used in charging the battery.

The cost of keeping the Edison battery full of pure water, and renewing the 21 per cent. solution of caustic potash and water once every eight months, averages about 3 mills per car mile, and this is all the battery maintenance required to keep the battery up to its highest efficiency. The Federal Storage Battery Car Company, manufacturers of this car, have data to indicate that the battery will endure in ordinary car operation for a long period of years. They have been in use, without important deterioration, for five years, and there is no reason to doubt that they would not last as long as other ordinary railway equipment.

Estimating the cost of operating these cars, including crew, cost of power, and basing the cost of battery on the guaranteed life only, and including depreciation of the electric motors, car structure, truck, etc; with interest and all fixed charges, it is thought that 15 cents per mile will cover the entire operating expense.

Bettendorf Steel Car Plant

The late W. P. Bettendorf was a man whose inventive and mechanical genius has never been questioned, and the magnificent plant that stretches along the Mississippi river for nearly a mile stands as a monument to his ability for the building of the organization, which is to-day conducting one of the most successful manufacturing enterprises that furnishes equipment to the railroads of this country. Probably Mr. Bettendorf's personality and his genuineness have been largely responsible for the loyalty and the enthusiasm of the men who were associated with him in the building of the Bettendorf industry.

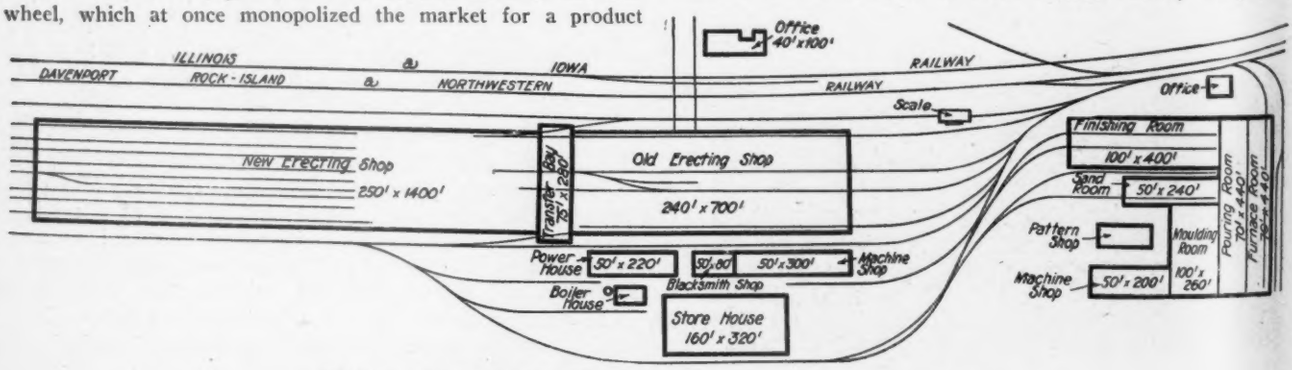


GENERAL VIEW OF BETTENDORF STEEL CAR PLANT, BETTENDORF, IOWA.

In 1886 Mr. Bettendorf went to Davenport, Ia., for the purpose of engaging in the manufacture of metal wheels. He had patented a new and novel metal wheel and a method of manufacturing it. Within a short time he had established the success of the new enterprise; and the decided merit of the new wheel, which at once monopolized the market for a product of that kind, has made it to-day the leading wheel for agricultural implements.

Always of an inventive turn of mind, Mr. Bettendorf next invented and became the patentee of a steel gear for farm wagons and other vehicles, and closing out his interest in the metal wheel plant, he organized a company, with himself at the head, for the manufacture of the wagon. This business quickly assumed large proportions, and in connection with it was begun the manufacture of some railway equipment specialties. Associated with him in his business enterprises was his brother, J. W. Bettendorf, on whom a great deal of the responsibility for the successful conducting of the business fell, and to whom large credit is due for the present large proportions to which the company has developed.

The invention by W. P. Bettendorf, and the manufacture of the I-beam car bolsters by the Bettendorf company, marked the beginnings of a railway supply manufacturing concern which had a most phenomenally successful growth within a period of a few years. Following the invention of the I-beam bolsters came the one-piece cast steel truck frames and other steel parts for the railway freight car. The immediate success which marked the introduction of these various railway freight car



PLAN OF CAR SHOP AND STEEL FOUNDRY; BETTENDORF AXLE COMPANY.

Specialties determined the inventor to devote his attention almost exclusively to the manufacture of steel railway car parts, and eventually cars in their entirety. The necessity soon became apparent for the establishing of a large separate plant for this purpose, and a site comprising about 40 acres was secured in 1902, and the first buildings now comprised in the present plant were erected. The location selected was just east of the

city limits of Davenport, where a new town was laid out and given the name of Bettendorf.

The indefatigable energy of W. P. Bettendorf, together with his mechanical knowledge and experience and his remarkable talent for organization, within a few years evolved a business of large proportions. Last year, when the business was only upon the threshold of its success, its founder, while most actively devoting himself to the enlargement of the plant and the business in every direction, was suddenly stricken and died on June 3, 1910.

J. W. Bettendorf, who had been associated with his brother since the beginning, shouldered the added responsibility and set to work to carry forward and complete the plans for the

BETTENDORF STEEL FOUNDRY.

further enlargement of the Bettendorf industry. The Bettendorf company, with J. W. Bettendorf at its head, and ably assisted by J. H. Bendixen, its vice-president, with a large and experienced organization, aims to develop at Bettendorf, Ia., the most comprehensive plant in the country for the manufacture of steel railway car underframes and parts, and eventually of steel cars of every description in their entirety.

With the several tracts recently purchased the grounds now in use cover an area of about 100 acres, and the buildings have a total aggregate floor space of upwards of 800,000 sq. ft., or about 18 acres, that is under roof. From the east side of the foundry to the tracks at the west end of the main shop is nearly a mile, and the total acreage of the land now owned by the company on which the present plant is located, and that which is held for future extension, amounts to 240 acres.

The original shop was a brick structure 700 by 240 ft. and in the recent improvements there has been added to it a main fabricating and erecting shop 1,400 by 250 ft., which is a steel frame and brick building, 60 ft. high, making one large main shop 2,100 by 250 ft. There has also been erected a large steel foundry, with wings arranged as shown in the illustration. To the south of the main shop is the power house, 220 by 50 ft., machine and blacksmith shop, 380 by 50 ft., and the storehouse, 320 by 160 ft.

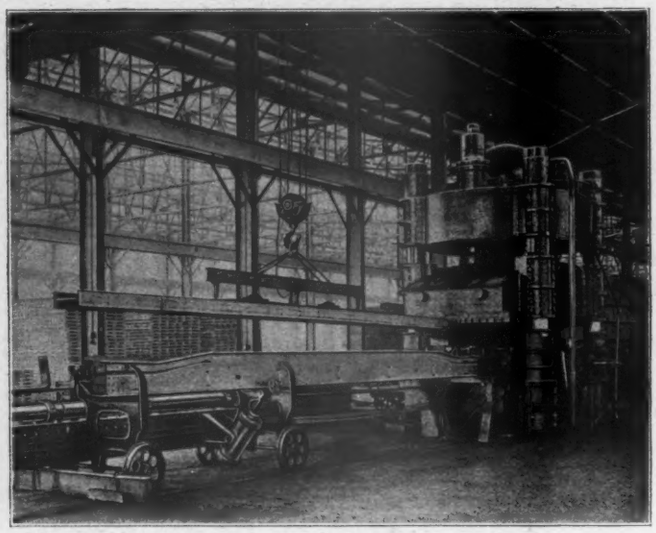
In the main shop, where the underframes and cars are fabricated and erected, there are fifteen electric traveling cranes of from 3 to 10 tons capacity, having approximately 60 to 70 ft. spans. In the older section of this shop, which is divided into five bays, are manufactured bolsters in two bays and small car parts and truck springs in two bays, the center bay being used principally for storage and assembling of parts. In the transfer bay, between the old and new sections, are located cranes, magnets, etc., for distributing material from the old shop to the four bays of the new addition. In the new section the two north bays are used for the erection of underframes of steel cars. In the next bay floors and sides are applied and in the south bay small parts and specialties are stored. There are 39 hydraulic presses in this shop, ranging in capacity from 50 to 250 tons, all of which have been specially designed and built by the Bettendorf Company. Running through the shop longitudinally are eight full gauge tracks connecting with the yard track system. Two locomotives and two locomotive cranes are used for transporting material around the yard. The heating of the shop is by Evan-Almiral hot water system, having 75,000 sq. ft. of radiation.

In this shop are manufactured the Bettendorf underframes for freight cars, of which there are now 45,000 in use, as well

ONE-HALF ERECTING BAY; BETTENDORF STEEL CAR SHOP.

as complete gondola, flat and tank cars and the well-known Bettendorf I-beam bolsters, of which there are over one-half a million in service. This concern is also gradually going into the manufacture of complete steel cars, and in fact has already turned out some steel box cars, which are now being tried out in service.

All of this equipment is manufactured from commercial sections, shaped cold in specially designed hydraulic presses of great power. Powerful lifting magnets are very generally used



2,500-TON HYDRAULIC PRESS FOR CENTER SILLS.

throughout the shop for handling the different parts and compressed air handling and feeding machines, specially designed by the company, form a most interesting part of the equipment.

The main machine shop is devoted entirely to the building and repairing of hydraulic presses, machines, etc., used throughout the plant. It is thoroughly equipped with up-to-date and strictly modern motor-driven tools in large sizes. A 5-ton crane serves the shop. The blacksmith shop is similarly used for building and repairing tools used in the shop.

The steel foundry was added to the plant last year and is one of the most modern and thoroughly well equipped plants of its kind in the country. All of the equipment for rapid output, accuracy of composition in the metal, and positive control of temperatures, etc., have been installed. Not the least interesting feature in this foundry is the perfection to which the annealing process has been brought and the extreme care used in annealing the many complicated castings. While this foundry will only supply a small part of the castings used by the company it is planned to gradually enlarge it until probably one of the largest steel casting plants in the country will be located there. At present it is used principally on orders that require immediate delivery and on castings that require special attention. Since it has been opened the company has found itself in a position to put on the market a satisfactory one-piece cast steel bolster.

The furnace bay, 70 ft. x 440 ft., is equipped with two 5-ton, 70-ft. span, electric traveling cranes for handling molds and castings; one 3-ton electric travelling wall crane; one 35-ton, 70-ft. span ladle crane with a 35-ton main hoist and a 5-ton auxiliary hoist and two 3-ton jib cranes for handling the furnace spouts. Through this department is a continuous sand conveyor for handling sand and conveying it to the sand mixers in the sand room. The two molding rooms, each 260 ft. x 50 ft., are equipped with two 5-ton, 48-ft. span, electric traveling cranes and miscellaneous jib cranes, pneumatic ramming tools, Bettendorf molding machines and core machines, and a continuous sand conveyor delivering sand at the various machines from the sand mixer. The sand room, 240 ft. x 50 ft., is equipped with concrete bins for sand storage, one 5-ton, 48-ft. span, electric crane with ½ yard grab bucket, two 25-ton continuous heavy sand mixers and two 15-ton facing sand machines. The annealing and chipping rooms, arranged in two bays each 400 ft. x 50 ft., are equipped with two continuous annealing ovens of the Bettendorf design which greatly expedite the process and render castings of a uniform quality. A Bettendorf hydraulic press, of 775 tons capacity, specially designed for this service, is used to straighten and test the truck frames to insure perfect alignment. Five ton, 48-ft. span, electric traveling cranes are used to carry castings to the various parts of these departments and for loading castings on cars.

A metal pattern and machine shop, 200 ft. x 50 ft., occupies another bay of this structure and is equipped with the necessary up-to-date motor driven tools to build and repair the metal patterns, molding machines and other machinery used throughout the foundry. In another bay, 140 ft. x 50 ft., is the wood pattern shop on the upper floor, equipped with motor driven, automatic start and stop planer, joiner, pattern grinder, saw tables, band saw, lathe, and revolving oil stone. On the ground floor of this building is a well arranged locker room, lavatory and swimming pool for the convenience of the employees.

The town of Bettendorf now has a population of about 1,500 people, and is to a large extent under the control of the Bettendorf Axle Company, through a town improvement company. This company under franchises obtained from the town council has put in a system of water works to supply the town from an artesian well and a stand pipe located on a bluff. The improvement company also supplies electric light to the town and private houses, the current being obtained from the shop engine room. It has spent about $100,000 in putting in the water and lighting plants for its employees' homes.

CONTINUOUS ANNEALING FURNACES.

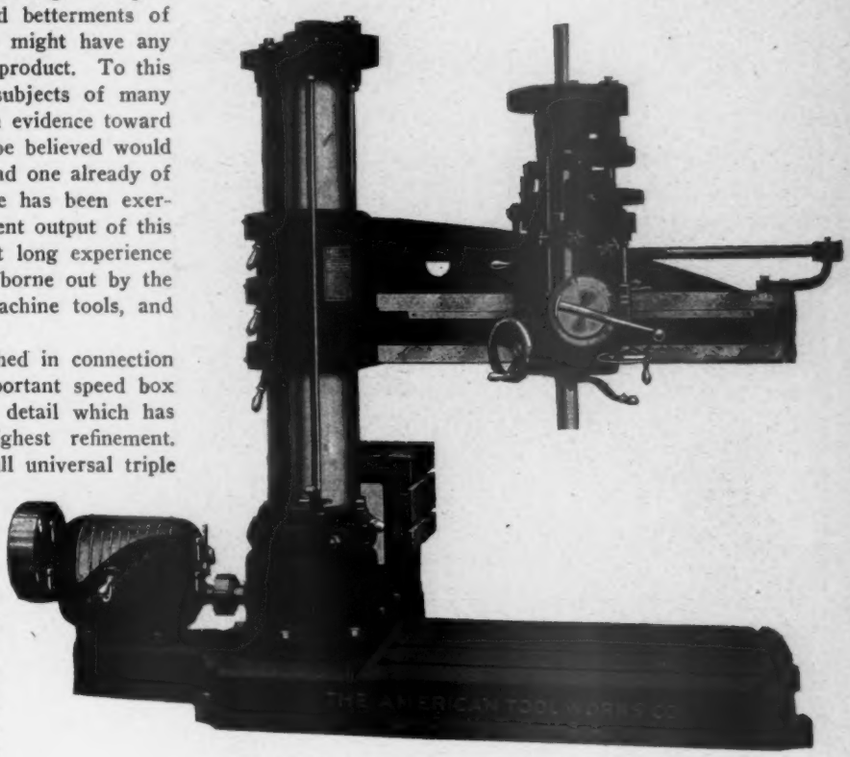
THE NEW YORK, NEW HAVEN AND HARTFORD R. R. has only one circuit for telephone train dispatching, that running from New Haven to Shelburne Falls, involving about 100 miles of wire and 40 stations.

NEW EIGHT CHANGE SPEED BOX

The high development which has been so characteristic a feature of the American Tool Works Company's output in recent years, has been largely the result of a most thorough and persistent effort to include in the re-design and betterments of existing machines every possible detail which might have any influence on the future utility of the finished product. To this end the several parts have been made the subjects of many elaborate tests, and more research has been in evidence toward securing the desired ends than it might well be believed would be devoted to a component mechanical part, and one already of proved efficiency. Nevertheless this exactitude has been exercised; and it is safe to assert that in the present output of this company the various details represent all that long experience and mechanical skill can dictate, a fact well borne out by the elegant and substantial appearance of the machine tools, and their immunity from adverse criticism.

In reviewing just what has been accomplished in connection with improving the various parts the all important speed box stands out prominently as an example of a detail which has been brought by this firm to its very highest refinement. Applied to the 4, 5, 6 and 7 ft. plain and full universal triple geared radial drill, as herein illustrated, it represents a development in this construction which will probably stand unique for some time to come.

Although the speed box mechanism is of very simple construction, which was in fact the feature particularly aimed at by the designers, the power is nevertheless such that it will enable a 6 ft. American radial drill to pull an 8 in. pipe tap. A compound tumbler gear is employed to obtain the speed changes, and this in connection with four gears on the cone provides 8 changes by means of only 7 gears. These changes, in connection with the triple-geared head mechanism, makes provision for 24 spindle speed. These speeds may be easily changed without shock to the driving mechanism, as the cone gears are kept rotating while changing speeds by means of an auxiliary drive between the pulley and cone shafts which is automatically engaged and disengaged by the raising and lowering of the tumbler lever when changing from one speed to another. This auxiliary drive is positive in its action, and is operated through a friction clutch which may be adjusted as required. The auxiliary drive is used only in making speed changes.

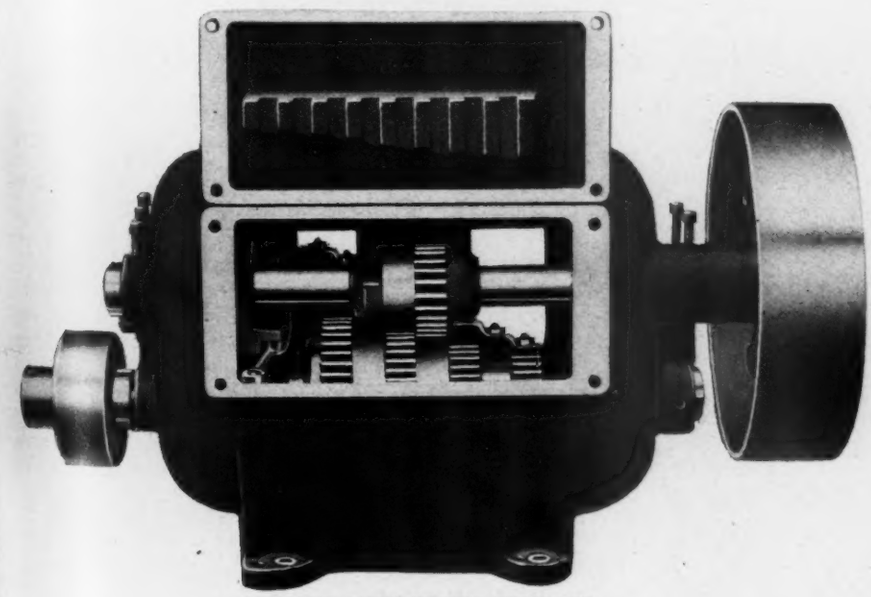


APPLICATION OF SPEED BOX TO RADIAL DRILL.

The tumbler lever is located in its various positions by a notched plate, which prevents the gears from being improperly engaged and also prevents the shifting of the tumbler lever until the auxiliary drive is thrown into operation. After the tumbler lever is located it is securely locked in its position by a latch and locking pin, thus preventing the tumbler gear being thrown out of mesh under heavy strains, and also preventing destructive vibration and rapid wear of the gears with the consequent noise and loss of efficiency.

All driving gears in this design are made from a special grade of steel carbonized and hardened, and are cut with Brown and Sharpe 20° involute cutters, which form a pointed tooth. This has been found to be the only proper and satisfactory tooth to use in a tumbler gear mechanism, as it permits engaging the gears without shock or clashing. To guard against the former an absorber in the line of drive takes care of all shocks and strains, thus insuring long life to the driving mechanism.

This style of box is readily interchangeable with the four-step cone pulley regularly furnished, and an American radial, equipped with this drive, can be easily converted into a motor driven machine at any time.



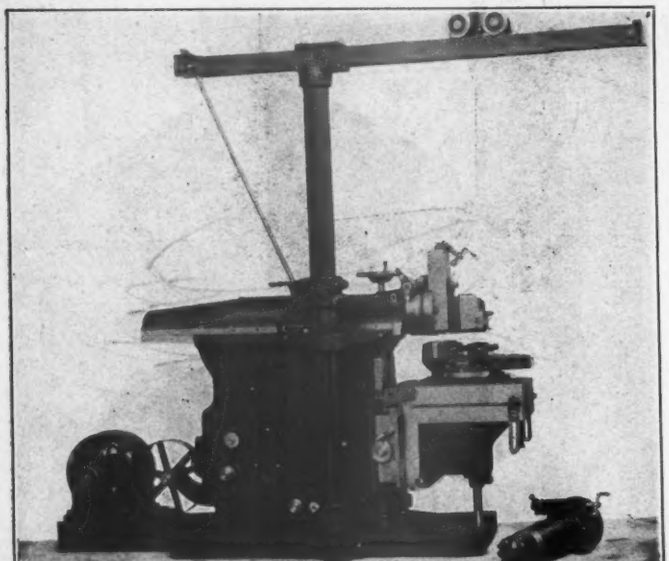
TNE NEW EIGHT-CHANGE SPEED BOX.

THE NEW HAVEN ROAD has for some time employed the staff system between Middletown and Cromwell, Conn., and is now making use of it in Rhode Island. It is a development of the old-time English staff, which from the earliest days of railroading has been employed.

ACCORDING TO THE GOVERNMENT REPORTS, there is a need for railroad ties in Chile, as there is a requirement this year for 100,000 ties with a pronounced scarcity.

THIRTY-TWO INCH BACK GEARED CRANK SHAPER

The accompanying illustration shows a 32-inch "Cincinnati" heavy duty back geared crank shaper, recently shipped by the Cincinnati Shaper Co., which is of particular interest on account



CINCINNATI SHAPER WITH JIB CRANE.

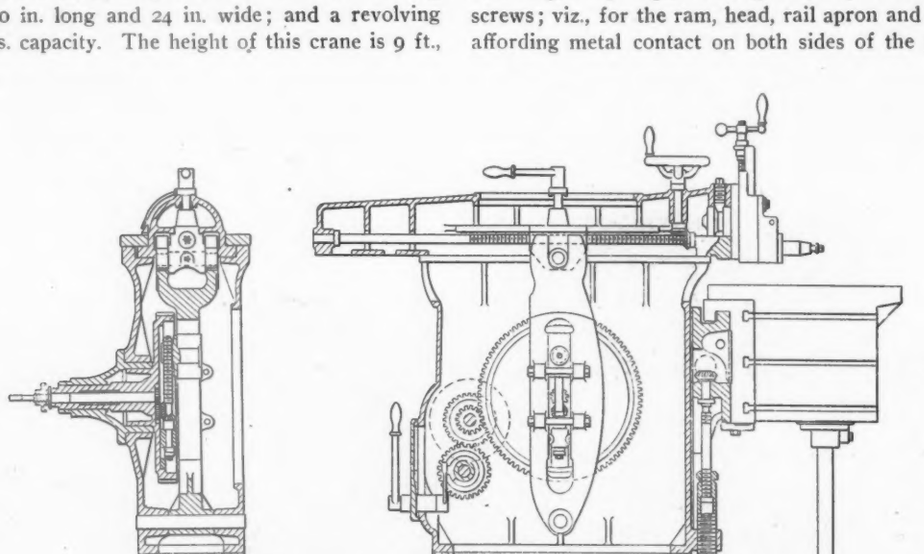
of the equipment which accompanied it. This latter included a constant speed motor of ten horse-power, belt driven through the gear box; a draw cut head, with power driven concaving attachment, as well as an extended circular feeding head, operated by both hand and power feed; a special knee table with tilting top, the top being 30 in. long and 24 in. wide; and a revolving jib crane of 1,500 lbs. capacity. The height of this crane is 9 ft., and due to this the illustration does not adequately convey the proper size of the machine, the weight of which is 9,370 lbs.

This shaper, which has the widest range for both light and heavy work possible to secure in this tool, has been designed with ample power, but the fact has not been overlooked that it must have the necessary rigidity to withstand the peculiar and excessive strains to which it is subjected. The system of jigs and the various tests to which the parts were subjected both in the manufacturing and in the finished machine, have secured accuracy, and the whole results in as perfect a tool as the state of the machinists' art permits.

To give an intelligent idea of this machine sectional views are given which clearly illustrate the design. As will be noticed in the vertical section through the center of the crank wheel or main gear, the journal of this gear has two diameters; the purpose, and one admirably accomplished, being to obviate any possibility of breaking at the junction of the gear. A very prominent point, also, is the close proximity of the rocker arm to the face of the gear, made possible by the crank block, together with its adjusting mechanism, being set well into the face of the gear, thus avoiding the usual overhang. Another particularly appealing feature is the dish-shaped form of the side of the column, which of a necessity bears all of the working strains of the machine, and the internal braces to the dish. The back gears, which are of the sliding gear type, with the four-step cone, or gear box, afford eight cutting strokes to the ram. The ratio of gearing is such that with the size of the cone pulley, this probably becomes the most powerful shaper of its stroke on the market.

The details of the machine are of much interest, and all material entering into its construction is of the highest class. All shafts are of high point carbon steel, and all are accurately ground, and all shaft bearings are amply large. The flat sliding surfaces, as well as the surfaces between the apron and the table are hand scraped to surface plates. The pinions are of cast steel, and all mitre gears are cut from solid bar. The rail is deep, heavy, ribbed horizontally, and strongly gibbed to the column; the cross traverse screw is provided with a graduated collar reading to .001 in., and a variable automatic feed, which is changeable from nothing to full feed while the machine is running. Ball bearings are provided for the elevating screw under the rail, and the screw, of telescopic form, is out of the way of falling chips.

The head swivels to any angle, and is graduated; the locking device is simple and highly efficient, and the down feed screw is provided with a graduated collar, reading to .001 in. There are full length taper gibs throughout, adjustable endwise by single screws; viz., for the ram, head, rail apron and crank wheel slides, affording metal contact on both sides of the gib. This, while a more expensive construction, is said to be preferable to gibs with set screws impinging with varying pressures at the several points in the length of the gib.



SECTIONS OF 32-INCH BACK GEARED CRANK SHAPER.

American Rail Joints are used extensively in England, Germany, France and Russia, and the value of the shipments runs into many millions annually.

Old Varnish May Be Removed from a metal surface by dipping it in equal parts of ammonia and 95 per cent. alcohol.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian Central	Apr. 4 May 12	Team Work in Transportation	C. Murphy	Jas. Powell H. D. Vought	P. O. Box 7, St. Lambert, near Montreal 95 Liberty St., New York
New England	Apr. 11	Compensating Employees for Industrial Accidents	James A. Lowell	Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Apr. 21	Reinforced Concrete for Railroad Work	J. P. H. Perry	H. D. Vought	95 Liberty St., New York
Pittsburg	Apr. 28	Development of the Locomotive Tube—Its Use and Abuse	F. N. Speller	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Apr. 14	Education and Transportation	F. W. Duke	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Apr. 14			B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	Apr. 17			Jos. W. Taylor	390 Old Colony Bldg Chicago
Western Canada	Apr. 10	The Industrial Use of Luminescence	J. W. Dorsey	W. H. Rosevear	100 Chestnut St., Winnipeg, Man.

FUEL ECONOMY.

WESTERN CANADA RAILWAY CLUB.

This timely subject was discussed at the club meeting, February 13, following the presentation of a paper by T. Duff Smith, Fuel Agent of the Grand Trunk Pacific Ry. Mr. Duff considers the kernel of the whole question of fuel economy to rest with the motive power department, or especially with the road foreman of engines, in seeing that the firemen use the coal intelligently and economically, and discussed his subject largely along these lines.

SOME ASPECTS OF THE RAILWAY OF TO-DAY.

RAILWAY CLUB OF PITTSBURG.

At the January 27 meeting of this club the above subject was ably presented by H. W. Thompson, Supt. Pennsylvania Lines west of Pittsburgh. The author discussed the various questions of the hour; competition, consolidation, the merits of Federal and State control of railroads, rebates and many other associated topics at some length and in a manner which rendered his contentions most convincing. The paper was well received and was accorded an animated discussion.

Future meetings of this club will be held at the Monongahela House instead of the Fort Pitt Hotel.

SIGNALING PRACTICE ON STEAM ROADS.

CANADIAN RAILWAY CLUB.

At the meeting on March 7 of this club, L. R. Clausen, Division Supt., Chicago, Milwaukee and St. Paul Ry., presented a paper on the above subject which was received with exceptional favor as a timely and valuable contribution to existing literature on the subject. After a brief historical review of signaling the author considered the work of the Signal and Maintenance of Way Associations at some length before proceeding with an analysis of the functions of the various signals now in vogue. The utmost practicable simplicity in railway signaling was advocated, and letters supporting this view from various operating and executive officers were read by Mr. Clausen as the conclusion to his able paper.

CHARACTERISTICS OF BRITISH RAILWAYS.

NEW ENGLAND RAILROAD CLUB.

One of the most instructive papers which have been presented before the railroad clubs for a long period was that by William J. Cunningham, Assistant Professor of Transportation of Harvard University, read at the meeting of this club on February 14. Mr. Cunningham has recently returned from a tour of observation on the lines of the British Isles, and has accumulated a wealth of data and statistical matter which on this occasion was presented in a most interesting manner, and was highly appreciated by the large attendance. The author divided his general subject into several heads: capitalization, organization, passenger train service, characteristics of passenger equipment, freight service, and locomotives, and each was discussed in a masterly manner which evinced thorough familiarity with the various details. Mr. Cunningham found several things to criticise, as might be expected when comparison was drawn with United States practice, but on the whole the tenor of his paper was quite favorable to British practice and served to throw light on much imperfectly understood procedure. The value of the address was enhanced by a large number of lantern slides of cars, locomotives and shops, from photos made by the author while on his trip.

CAR AND ENGINE EQUALIZERS.

NORTHERN RAILWAY CLUB.

H. Van Dyken, of the Duluth and Iron Range Ry., at the January 28 meeting of this club read a paper on the above subject in which the rather startling suggestion was offered that all spring rigging, springs, saddles, equalizers, hangers, pins, and gibs be done away with. The contention was advanced by the author that these parts fall short, or, in fact, fail altogether, in performing their true functions, and he offers the following as a more advantageous arrangement: the top rail of the main frame to be made hollow, and pumped full of zero car oil on which the engine rides; over the center of each driving box to be a perpendicular hole four inches in diameter, and in the latter to be pressed a quarter inch brass bushing. In this bushing a plunger standing on the driving box is to work, and is intended to impinge on the oil, thus securing perfect equalization at all times for all drivers. The paper was received without discussion.

ELECTRIFICATION OF STEAM RAILROADS.

NEW YORK RAILROAD CLUB.

The seventh annual electrical night of this club was in many respects the most successful one of the series. It was given up chiefly to reports of railroad officials on the operating features of electrified steam railroads and a report by Prof. George F. Swain of Harvard University, a member of the Massachusetts Joint Board on Metropolitan Improvements, on how this board has considered the problem of electrification as applied to Boston and its suburbs. This was a most excellent clean-cut discussion of the whole problem of electrification of suburban lines as they exist in Boston and clearly traced the line of reasoning which led the majority of this board to advise against compulsory legislation on this subject. Prof. Swain's remarks will be largely republished in the next issue of this journal.

A communication from James A. McCrea, general superin-

tendent of the Long Island Railroad, pointed out the many advantages which experience had proven the multiple unit system of control to have in heavy suburban traffic. At present this company has 164 miles of track operating electrically and during its five years' service there has been but one serious delay which could be charged to electrical equipment. Mr. McCrea stated that electrical operation had increased the suburban limits from 24 to 30 miles. He also stated that the multiple unit system makes it possible to handle eight or ten trains per hour per track at a terminal, this being largely due to the decreased amount of switching required. H. Gilliam, electrical superintendent of the New York, New Haven & Hartford, stated that in operating over the 33½ miles from the terminal, current was used for only 12 miles, or during the fifty minutes required for covering this run, current was on for only seventeen minutes. Steam locomotive engineers can successfully operate electric locomotives after a few hours' instruction per day for two weeks.

W. S. Murray, electrical engineer of the New York, New Haven & Hartford Railroad, is strongly in favor of the single-phase system for trunk line service under any condition. This company now has 100 miles of single track electrified and has under way the electrification of over 372 miles. He stated that the average delay for all electrically operated trains on the New Haven Railroad were such that a train could cover a distance equal to that from New York to San Francisco and return eleven times with a delay of but one minute.

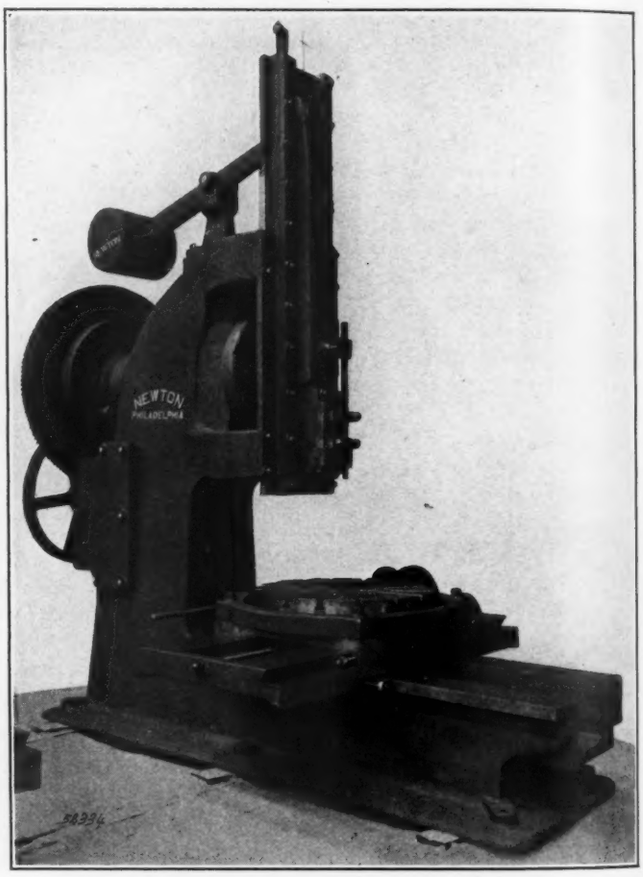
Other members speaking on the subject in general were Wm. McClellan, a member of the club's committee on electrification; W. B. Potter and A. H. Armstrong of the General Electric Co., the latter stating that the New York Central electric locomotives run from 1,200 to 1,300 miles between inspections.

TWENTY-FOUR INCH CRANK SLOTTER

In pursuance of its policy to make an annual redesign of many machine tools embodied in its output, the Newton Machine Tools Works Co., of Philadelphia, Pa., has included therein its line of crank slotting machines, the 24 in., or maximum size of which is illustrated herewith. This machine is of the same design from and including the 15 in. size up. A consideration of the principal dimensions and constructive details is of interest and will illustrate the refinement which machine tool design has attained in producing a compact and exceedingly powerful tool without the cumbersome features so generally associated with slotters.

The maximum stroke is 24 in.; minimum distance from the bottom of the tool holder to the work table, 3½ in.; maximum distance from the bottom of the tool holder to the work table, 47½ in.; minimum distance from the bottom of the cutter bar guide to the work table, 8 in.; maximum distance from the bottom of the cutter bar guide to the work table, 24 in., and distance from the front face of the tool slide or holder is 36 in. The work table is 40 in. in diameter over the working surface, and there is available 48 in. of in-and-out motion to the cross saddle, and 48 in. of adjustment of the circular saddle on the cross slide.

The machine occupies a floor space of 11 ft. 7 in. by 48 in. on the base, and the over-all length of the cross saddle is about 8 ft. The cutter bar has square locked gibbed bearings in the guide, is counterweighted, and carries a relief tool apron with vertical and horizontal steel faced clamping surfaces with necessary clamps. It is arranged for elevation to suit the varying lengths and heights of work, and the face of the bar is grooved, into which corresponding tongues on the yoke washer fit, to relieve the stroke adjusting screw of strain when taking cuts. The side adjustment of the bar in the guide is made by a continuous taper shoe which is considered a very great advantage over the former method of using an English shoe having elongated holes, and the adjustment made by set screws. The counterweight arm is forged of steel; the cutter bar guide is of very heavy construction; has square locked gibbed bearings to the frame, and is adjustable by hand to support the bar when cutting in its lowest positions. The face of the crank plate is grooved, and corresponding tongues on the connecting rod fit into these grooves to relieve the stroke adjusting screw when taking cuts. The bearing or trunnion for the large driving plate gear is cast solid with the frame, and the drive is by means of motor or four-step cone through Whitworth motion, giving quick return to the stroke.



HIGHLY DEVELOPED HEAVY SLOTTER.

The work table is of very heavy construction with ample clamping facilities, and has a large circular bushed bearing in the cross slide, and the table is surrounded by an oil pan, the top edge of which serves for a bearing for the continuous circular shoe. The rotating worm wheel is cut from the solid and the table is indexed with a pointer mounted in a small slot. Adjustment of the circular table saddle to the cross slide is made by means of taper shoes, and the cross saddle has square locked gibbed bearings to the base. A distinct departure in this type of machine is, that the in-and-out feed screw remains stationary and the adjustment is obtained by a combination bevel gear and nut, which gives a very substantial construction, and permits of a bearing on each end of the adjusting screw. There is provided variable reversible automatic power feed to the circular, cross, and in-and-out movements, in addition to hand adjustment. The approximate net weight of this machine arranged for motor drive without the motor, or for belt drive without the countershaft is 30,000 pounds, so that it can be realized that this machine is of exceptionally heavy construction; in fact, the engineers of equipment from the different railroad companies and manufacturing plants advise that these machines are heavier than necessary for any service that is liable to exist, although they are flexible in operation on account of the concentration of the levers of control.

PERSONALS

E. M. SANJULE has been made roundhouse foreman of the Santa Fe at Gallup, N. M.

FRANK H. KAUB, said to be the first master mechanic of the Union Pacific R. R., died recently in Denver, Colo., at the age of 78 years.

WM. STAPP has been made general car foreman at La Junta, Colo., on the Santa Fe, succeeding D. Hurley, transferred to Topeka, Kans.

W. Q. DAUGHERTY has been appointed master mechanic at Jackson, Tenn., on the Mobile and Ohio R. R., to succeed G. L. Lambeth, transferred.

F. J. SMITH has been appointed master mechanic for the Chicago Great Western Ry., with headquarters at Stockton, Ill., succeeding J. M. Robb, resigned.

J. E. ROBERTS has been made machine foreman of the Big Four shops at Beech Grove, Ind., and J. Martin succeeds Mr. Roberts as tool foreman at that point.

W. J. MAYBERRY has been made general foreman of the Trinity & Brazos Valley R. R. at Tomball, Tex., vice F. P. Cleaver, resigned to accept service at Portland, Ore.

E. J. MCMAHN has been made general foreman of the Santa Fe at La Junta, Colo., vice M. M. Myers, resigned to accept a position with the Missouri Pacific Ry.

A. STEWART, general superintendent of motive power and equipment of the Southern Railway, has had his authority extended over the Virginia & Southwestern Ry.

F. H. GREENE, general purchasing agent of the New York Central Lines, at New York City, has resigned to become president of the Hale & Kilburn Manufacturing Company, Philadelphia, Pa.

E. E. BOOTH has resigned as roundhouse foreman of the Missouri, Kansas & Texas Ry. at Wagoner, Okla., to accept a similar position with the Wichita Falls & Northwestern R. R., at Wichita Falls, Tex.

J. H. BRANSFORD has been appointed a general foreman of the Chesapeake & Ohio Ry., with office at Thurmond, W. Va., succeeding Frank J. Walsh, resigned to go to the Chicago Pneumatic Tool Company.

HENRY SHULTE, assistant road foreman of engines of the west end of the Buffalo division of the Lehigh Valley Railroad, has been appointed road foreman on the same district, with headquarters at Buffalo, N. Y.

JOHN H. GUESS, formerly general purchasing agent of the National Railways of Mexico, has been appointed assistant general purchasing agent of the Grand Trunk Railway, with office at Montreal, Que., Canada.

R. L. DOOLITTLE, master mechanic of the Atlanta, Birmingham & Atlantic Ry. with office at Fitzgerald, Ga., has been appointed superintendent of motive power, a new position, and his former office has been abolished.

C. J. STEWART, formerly master mechanic of the Western Division of the New York, New Haven and Hartford Railroad, has been transferred in a similar capacity to the Boston Division, *vice* James Hocking, resigned.

W. H. GRAVES, formerly general foreman on the Fort Worth & Denver R. R., and first president of the International Railway General Foremen's Association, has been made foreman of the Rock Island Ry. at Liberal, Kan.

G. L. LAMBETH, master mechanic of the St. Louis division of the Mobile & Ohio R. R. at Jackson, Tenn., has been appointed master mechanic of the Mobile division at Whistler, Ala., vice E. G. Brooks assigned to other duties.

C. N. PAGE has been appointed master mechanic of the Lehigh Valley R. R. at Auburn, N. Y., succeeding J. N. Mowery, resigned. Mr. Page will perform his new duties in connection with his position as trainmaster, which he still retains.

M. R. SMITH, master mechanic in charge of terminals of the Chicago, Indianapolis & Louisville R. R., at Lafayette, Ind., has been appointed shop master mechanic, with office at Lafayette, succeeding O. S. Jackson, resigned to go to another company.

T. A. LAWES, master mechanic of the Chicago, Terre Haute & Southeastern Ry., at Terre Haute, Ind., has been appointed mechanical engineer of the New York, Chicago & St. Louis R. R., with office at Cleveland, Ohio, succeeding L. B. Morehead, resigned.

J. N. MOWERY, who recently resigned the position of master mechanic at Auburn on the Lehigh Valley Railroad, has been appointed master mechanic of the Western Division of the New York, New Haven and Hartford Railroad, with headquarters at New Haven, Conn.

A. S. ABBOTT, formerly division master mechanic at Fort Smith, St. Louis and San Francisco R. R., has been transferred to Sapulpa, Okla., as division master mechanic in charge of the Southwestern division and the Creek and Sherman sub-divisions of the Red River division.

H. E. CREER, general car foreman of the Missouri Pacific R. R. at Atchison, Kan., has resigned to become mechanical expert for McCord & Company, Chicago, succeeding the late D. J. McOscar, who died on December 22, 1910. Mr. Creer's headquarters will be in Chicago.

G. J. DUFFEY, assistant master mechanic of the Lake Erie & Western Ry., the Fort Wayne, Cincinnati & Louisville Ry., and the Northern Ohio R. R., at Lima, Ohio, has been appointed master mechanic, with office at Lima, succeeding F. H. Reagan, resigned.

JOHN F. ENSIGN, of Colorado, has been appointed by President Taft to be chief inspector of locomotive boilers in accordance with the new law just adopted by Congress. Frank McManany, of Oregon, and G. P. Robinson, of New York, have been chosen to be assistant chief inspectors in the West and in the East respectively.

WILLIAM HENRY, division master mechanic of the St. Louis & San Francisco R. R. at Sapulpa, Okla., has been transferred to Monett, Mo., as division master mechanic in charge of the Kansas and the Western divisions, succeeding Frank Burns, who has been transferred to Fort Smith, Ark., in charge of the Central, the Arkinda, and the Ardmore sub-divisions of the Red River division.

A. C. ADAMS has resigned as division master mechanic on the New York, New Haven and Hartford R. R. to become superintendent of motive power of the Spokane, Portland and Seattle R. R., with office at Portland, Ore. He will have charge of the maintenance of motive power, machinery and equipment, and conjointly with the general superintendent, the operation of the rolling stock. Mr. Adams has also been appointed superintendent of motive power of the Oregon Electric and the United Railways Co., with office at Portland, Ore.

PAUL RAYMOND BROOKS, formerly on the staff of the *Railway Review*, died at the home of his aunt in Chicago on March 11. Mr. Brooks graduated from the Massachusetts Institute of Technology in 1900, and after serving four years as a special apprentice on the Chicago, Burlington and Quincy Railroad, went with the Railway Appliance Co. He was later city salesman for the Otto Gas Engine Co. in New York, which position he resigned to become general manager of the Machinery Sales Co. of New York. Later he joined the staff of the *Railway Review*, being attached to the Eastern office, and upon the death of his father, about a year ago, he went to Texas to take charge of the large real estate interests of the family in that State. He was a member of the Amer. Soc. Mech. Engrs., Technology Club of New York, New York Railroad Club and was successively an officer in the Illinois Naval Reserve and the 1st Bat. New York Naval Militia.

CATALOGS

BALL BEARINGS.—The Hess-Bright Mfg. Co., of Philadelphia, Pa., has supplemented former information on this subject by the issue of two leaflets dealing respectively with rope drive and conveyor sheaves, and annular (radial) bearings.

RIVET HEATING FURNACES.—In Bulletin 27 the Rockwell Furnace Co. illustrates a line of portable rivet heating furnaces and miscellaneous furnaces which is of exceptional reference value. The descriptive matter is also enhanced by a page of valuable practical pointers on rivet furnaces and rivet heating.

LOCOMOTIVE FLUES.—Through a leaflet entitled "When a Train is Behind Time," the Detroit Seamless Steel Tube Co., of Detroit, O., points out convincingly the merits of its cold drawn, seamless, open hearth steel locomotive flues, and indicates how through their use flue troubles can be reduced to a minimum.

ENGINE TYPE GENERATORS.—The Sprague Electric Co.'s bulletin No. 111 partially lists and illustrates installations of its engine type generators. The half tone work is very good, and although the bulletin does not include descriptive matter, it is of considerable interest in view of the magnitude of the installations represented.

PURDUE UNIVERSITY.—A recently issued bulletin by this well known university describes and illustrates its shops and engineering laboratories and contains much valuable information in regard to each shop in detail. The various departments and their arrangement are shown in many well executed half-tones, and the scope of the work undertaken therein is fully and carefully explained.

ACETYLENE BURNERS.—The American Lava Co. of Chattanooga, Tenn., has just put out a very attractive catalog which will prove particularly attractive to those interested in the general subject of acetylene burners. All styles of the latter as manufactured by this company are fully described and illustrated and it is clearly evident that in the preparation of

the book every effort was made to render the information as complete as possible.

GAS DRIVEN MINING LOCOMOTIVES.—The Milwaukee gas driven locomotives are described and illustrated in a catalog recently issued by the Milwaukee Locomotive Mfg. Co., of Milwaukee, Wis. These locomotives have been on the market for a number of years and have proved remarkably well adapted for service around industrial plants. The catalog gives a good illustrated description of the machine, and portrays the various types which comprise the output.

TRACK MOTOR CARS.—The Burton W. Mudge Co., of Chicago, Ill., has just issued an attractive illustrated circular describing the Adams motor car and its application to railroad work. These cars have a speed anywhere from 3 to 45 miles per hour, and through the sensible distribution and mechanical balance of its 300 pounds weight embodies an unusual factor of safety. The racking motion common to small motor cars is eliminated in its construction, and its easy riding qualities are a most prominent feature.

JOURNAL BOX PACKING.—The Franklin Mfg. Co., of Franklin, Pa., under the title "Suggestions Relative to the Introduction and Use of Journal Box Packing for Railways," has just put out a very interesting booklet which deals exhaustively with this always important question. It is pointed out that Perfection Packing, as manufactured by this company, has been demonstrated, through extensive experiments in physical and chemical laboratories, to be a packing which adequately meets every essential requirement of railway service, and many valuable truths are embodied in regard to the subject in general.

MONEL METAL.—This product of the Bayonne Casting Co., of Bayonne, N. J., is thoroughly described in a recently issued catalog which is complete in all information which might be desired on the subject. A table of the physical properties of Monel Metal is included, which will be of value to those interested. Since the qualities of this metal have become more generally known its field of application has rapidly extended, and it can now be furnished in any of the following forms: castings, rods and bars, sheets, wire, forgings, ingot, and shot. Much valuable matter is included in the catalog in regard to the proper treatment and handling of this metal.

PEDESTAL CONCRETE PILING.—Under the title "The Pedestal Pile" the MacArthur Concrete Pile and Foundation Co. of New York, N. Y., has issued a 61-page handsomely illustrated book for engineers, architects, owners and contractors, which describes the pedestal concrete pile, and discusses the relative merits of wooden and concrete piles of various types. The pedestal pile, which is described at some length, is a distinct and radical improvement in piling construction. It differs from the ordinary wood or concrete pile in that a large carrying capacity, in addition to that due to frictional adhesion, is derived from the direct bearing power of a broad base resting in firm and compact subsoil.

CAR VENTILATION.—This important and timely subject is thoroughly considered in a very attractive catalog recently issued by the Burton W. Mudge Co., of Chicago, and which describes and illusetrates the Garland system of ventilation. The catalogue is replete with handsome half-tones of many prominent trains of the country, in connection with which this system has been adopted. Its application to refrigerator cars is specially featured in the latter part of the book, where eight pages are devoted to descriptive matter and illustrations which clearly portray the general arrangement and details. The catalog will be found very valuable for reference in view of the general interest which is now evinced in the Garland system.

AMERICAN LOCOMOTIVE CO.—The classification, analysis and comparative heating values of different grades of coal forms the subject of "Bulletin No. 1008" which proves to be a most valuable addition to the existing information on the subject. It is shown that locomotives burn, approximately, 100 million tons a year, or one-fifth of the total amount of coal mined annually in the United States. This data and much more of the same interesting character was originally compiled and published in voluminous reports by the United States Geological Survey, and portions of it in condensed form were considered of sufficient interest and value to readers of the American Locomotive Company's bulletins to warrant publication in that form. The tables accompanying the bulletin are of especial value through the concise manner in which the various subjects are epitomized for convenient reference.

MALLET ARTICULATED LOCOMOTIVES.—Bulletin No. 69, issued by the Baldwin Locomotive Works, constitutes an important addition to the literature on this timely subject. The book is devoted to a consideration of this power as built for the Atchison, Topeka and Santa Fe Railroad exclusively, and for which the Baldwin Works has recently completed an order for forty locomotives of this type. Owing to special features in the construction of these engines, the bulletin describes them in detail, and does not omit mention of the two "flexible boiler" locomotives, Nos. 1158 and 1159, which embody in their design a decided innovation. The flexible boiler connections used on these two engines are entirely different, engine 1158 having a double ball-jointed connection, while engine 1159 has a pleated or bellows form of connection. The details of this novel arrangement are fully described and illustrated in the book, and the information is presented in an attractive form.

NOTES

CARNEGIE STEEL CO.—James J. Dongan, formerly superintendent of the 39th street, Pittsburg, plant of this company, died on March 5. He was 64 years old.

STANDARD STEEL CAR CO.—This company is said to be having plans prepared for an addition to its plant at Butler, Pa., but the details of the proposed improvement have not been made public.

NATIONAL MALLEABLE CASTINGS CO.—In a decision recently rendered by Judge Rellstaf in the United States Circuit Court for New Jersey, the validity of the patents on the Climax coupler was established in favor of this company.

FIRTH-STERLING STEEL CO.—David E. Jackman, of the firm of E. S. Jackman & Co., Chicago-Cleveland-Pittsburg, has withdrawn to accept the position of treasurer with the Firth-Sterling Steel Co. of McKeesport, Pa., and assumed his new duties on April 1.

S. OBERMAYER CO.—Its New England branch is now located at 44 Stonehurst street, Dorchester, Boston, Mass., with Wm. Fitzpatrick in charge, and any inquiries or orders for foundry facings, supplies and equipment forwarded to that branch will have immediate attention.

A. EUGENE MITCHELL.—Prof. W. F. Schaphorst, of the mechanical engineering department of the New Mexico College of Mechanical Arts, has resigned his position there to become a technical writer on the staff of A. Eugene Michel, advertising engineer, New York City.

CINCINNATI PUNCH & SHEAR CO.—Announcement is made by C. J. McDiarmid, trustee in bankruptcy for the above firm, that bids will be received for all its assets up to April 4, 1911, except the accounts and bills receivable. The assets, which may be inspected at the plant, 1422 Plum street, Cincinnati, O., consist of a full equipment of machinery, tools, etc., and about $5,000 worth of finished product ready to ship.

McCORD & CO.—H. E. Creer, who was formerly general car foreman of the Missouri Pacific Railroad at Atchison, Kansas, and general car foreman of the Pere Marquette R. R., in charge of the Grand Rapids and Detroit districts, has accepted serice as mechanical expert with McCord & Company, succeeding the late D. J. McOscar, who died of pneumonia on December 22nd last. Mr. Creer's headquarters will be at the Chicago office in the People's Gas Building.

RELIANCE ELECTRIC & ENGINEERING CO.—This company announces removal to new offices and shop on Ivanhoe Road, Cleveland, O. The new plant is of reinforced concrete construction with saw tooth roof, and particular attention has been paid to arrangement, lighting and all other features which tend to manufacturing efficiency. The new quarters afford double the former capacity, and place the company in a position to give motor orders the best possible attention. It is requested that correspondence be addressed to Collinwood Station, Cleveland, O.

HOBART-ALLFREE CO.—J. Fremont Murphy, mechanical expert, whose office has been in the Hudson Terminal Building, 30 Church street, New York, has associated himself with The Hobart-Allfree Co., 1380 Old Colony Bldg., Chicago, and will devote his entire attention to the Allfree system of steam distribution as applied to locomotives. Mr. Murphy was for many years connected with the American Locomotive Co. as mechanical engineer, and later superintendent of the Cooke Works at Paterson, N. J., and is, therefore, thoroughly conversant with modern locomotive design and methods of construction.

KENNICOTT CO.—It is announced by this company, of Chicago Heights, Ill., that to provide adequate facilities for its steel car department an extensive addition is being made to its plant and the most modern machinery and appliances are being installed to economically handle heavy steel work. The car department is one of the newer lines of the Kennicott Company, and is becoming a very important part of its business. The department is prepared to handle structural steel freight and passenger equipment, steel underframes for all classes of equipment, steel tank cars complete, steel re-enforcers or strengtheners for wooden equipment, trucks and mine cars and general plate construction.

SUFFERN & SON.—Announcement is made that a "Department of Effective Organization" under the direction of C. J. Morrison, has been organized to aid in securing the most effective organizations and the most efficient methods in manufacture and business. The work of this department is to obtain the desired ends through the elimination of unnecessary work, expenses or investments, and through turning unproductive into productive factors. Such a study and analysis of business requires special training and experience, and the ability to look at the work from an outside perspective. It demands a close attention which those actively engaged in the business itself can rarely give, and is the kind of service which this new department under Mr. Morrison's direction will without doubt render most satisfactory.

Crawford Underfeed Locomotive Stoker

ON THE PENNSYLVANIA LINES WEST OF PITTSBURGH D. F. CRAWFORD, GENERAL SUPERINTENDENT OF MOTIVE POWER, HAS DESIGNED AND DEVELOPED TO A SUCCESS A TYPE OF LOCOMOTIVE STOKER WHICH FEEDS THE FUEL INTO THE FIRE BOX THROUGH NARROW TROUGHS BETWEEN SECTIONS OF THE GRATE AND UNDERNEATH THE FUEL BED.

When fresh fuel is fed into the firebox the first step in the process of combustion is the distillation of the gaseous or volatile matter. The combustion of these gases, in the case of bituminous coals, produces a large proportion of the heat obtained from the total combustion of the fuel, in fact in some coals it forms the principal source of heat. This volatile matter consists very largely of hydrocarbon gases and for its combustion requires the presence of a sufficient supply of oxygen and a temperature of at least 1,800 degs. When green coal is thrown on top of a bed of fire these gases, which are distilled off very rapidly, must be supplied with the necessary oxygen, either through openings above the fire level, as for instance the fire door, or excess of air passing through the fuel bed. Further, the area of the firebox above the fuel bed must have a temperature of at least 1,800 degs. to produce the desired combustion. When most of the air for this combustion is supplied from above the grates the temperature must be decidedly higher in order to neutralize the cooling effect of the entering air. If either one or the other of these conditions is absent the volatile matter passes off practically unconsumed, resulting in smoke and a decided loss of heat.

When green coal is fed to the fire from underneath the fuel bed the gases as they are distilled off by the radiated heat have to pass through the incandescent bed of fuel above, and while on this passage, if the arrangement is proper, they meet the required oxygen coming through the grates and ideal conditions for perfect combustion are present, resulting in a smokeless fire as well as the maximum amount of heat.

The combustion of the coke or residue after the gases have been burned is a much slower process and requires only the assurance of an ample supply of oxygen.

In the development of locomotive stokers in general, practically all of the designs have in a way imitated the action of the firemen by feeding the fuel on top of the fire bed. If this is done properly complete combustion will take place the same as occurs when a skilful fireman is at work. It has been found with several stokers of this type, however, particularly when in the hands of men who were not skilful firemen with the shovel, and even under certain conditions with expert handling, that considerable smoke will be formed at various times, indicating incomplete combustion.

In view of this and the results obtained by underfed stokers in stationary practice, D. F. Crawford, in developing a stoker on the Pennsylvania Lines West of Pittsburgh, became convinced that for the most satisfactory results under all conditions of handling, the underfed principle was the proper one. He also believed that the stoker should not only feed the fuel into the firebox, but that it should handle it directly from the tender without the necessity of the fireman's assistance. After several years' study and experiment along these lines the stoker and conveyor shown in the accompanying illustration has proved to be a most gratifying success in actual service. This result has been obtained by a steady and constant development in the application of the principle, and while the machine as now designed is beyond doubt successful, it is not felt that it will not be found capable of further refinement and improvement. At the present time it has been fitted to several locomotives which have been in regular service for a year or more without any serious trouble with the stoker.

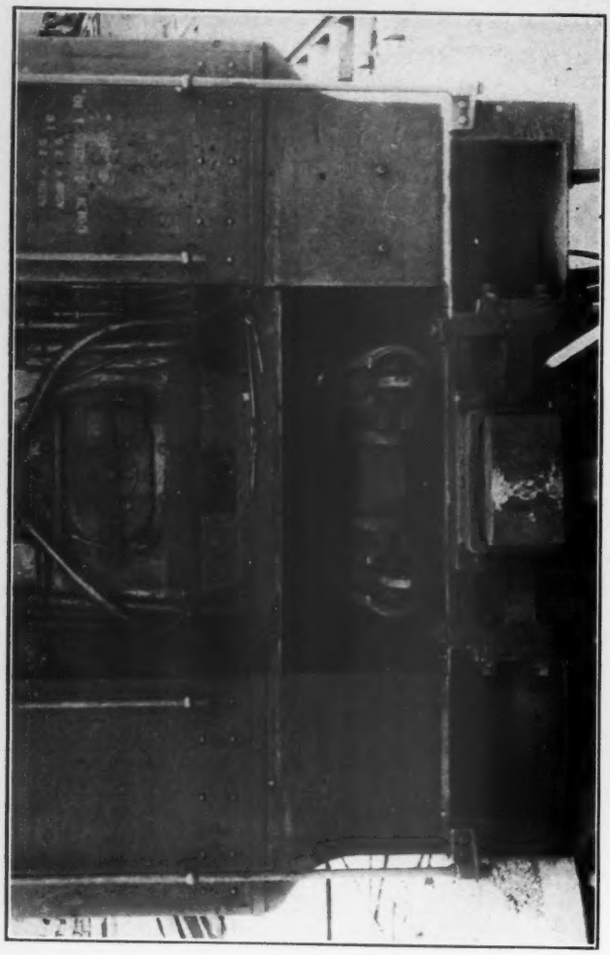
From the beginning it was believed by the designer that the stoker on a locomotive should not interfere in any way with the fireman feeding the coal with the shovel in the customary manner in case of the machine getting out of commission for any reason or where it might be necessary to assist the stoker with hand firing. He also felt that the whole design should be marked with the utmost simplicity, that the mechanism should be strong and rugged and contain as few parts as possible. The Crawford stoker is remarkable in both these respects.

In the cab the only thing outside of the firebox to indicate the presence of a stoker are two small covered hoppers rising about 4 in. above the deck, close to the boiler head. Everything else is out of sight and out of the way. Its simplicity is evident from the drawings.

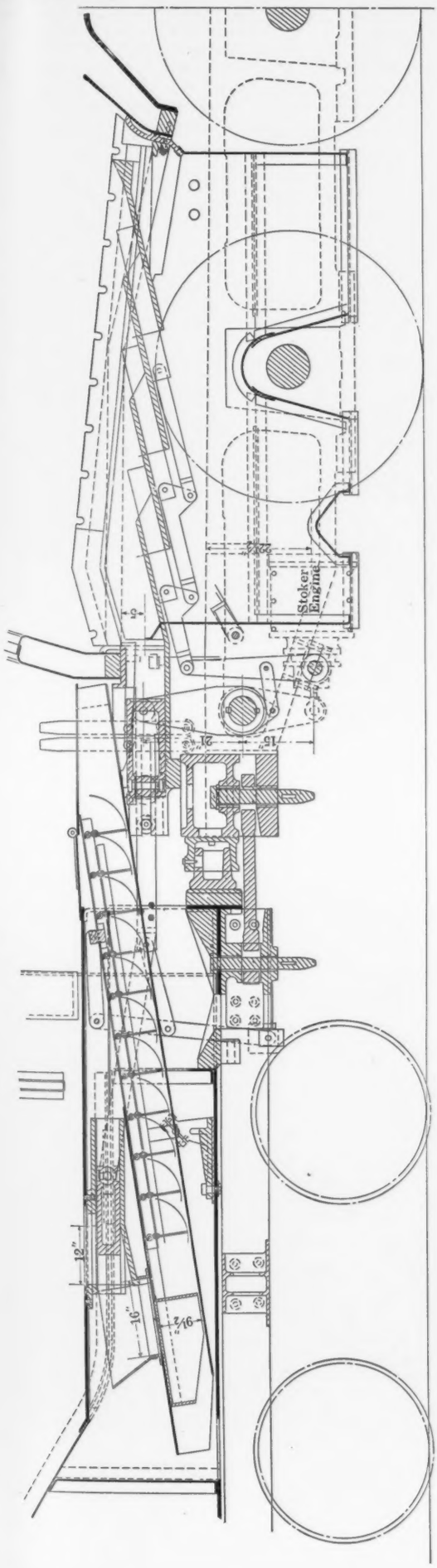
In general arrangement the stoker consists of two troughs secured under the mud-ring, their upper edges slightly above the level of the grates. These cast iron troughs are about 9½ inches in width and 20 in. in depth at the back end and shallow up to no depth at the front end of the grates. The green coal is forced into each by an 8 in. reciprocating plunger located back of and just below the mud ring. It is further distributed toward the front end by three small plungers spaced along the bottom of the trough at the proper inclination to force the coal forward and upward to gain the most satisfactory distribution. All of the plungers in the bottom work in unison and opposite to the main plunger. They are all connected through links, as shown, to a crank on the main operating shaft, which extends across and is carried in bearings bolted to the frame. This shaft receives its motion from a steam cylinder secured outside of the frames on the left side. The main plunger has its connection to an arm on the opposite side of the shaft.

The steam cylinder has a diameter of 15 in. and a 12 in. stroke and is fitted with a regular top head valve gear of the Westinghouse 9½ in. air pump, the reversing rod of which extends down through a cored passage in the trunk piston employed. This cylinder provides power and movement for all parts of the stoker, including the conveyor, and its steam supply is controlled by a globe valve on the fireman's side of the cab.

The conveyor extends from below an opening in the floor of the tender on a slight inclination upward to the discharge over small hoppers above the main plunger of the stoker. It is of the reciprocating type and includes a combined increment loader and crusher working just below the opening in the tender floor. This rectangular plunger receives its motion through a link connection from the arm on the main operating shaft that give the motion to the main stoker plunger. The coal from the tender drops through the opening in the floor in front of this loader and crusher and is discharged into a trough about 9½ in. in depth and 18 in. wide. Over this is a reciprocating frame carrying a series of hinged fingers, arranged to have free movement forward of the vertical position, but prevented from moving back of it. As this frame reciprocates, being connected through links to the same arm that operates the loader, the fingers slide over the top of the coal on the backward stroke and dropping down move the fuel forward in the trough on the forward stroke, eventually discharging it in front of the main stoker plunger, which working in unison with them is in proper position to receive the charge and on the return stroke to force it into the trough. Although there are two troughs and plungers, there is but a single conveyor, the discharge being arranged so that half of the coal brought up drops in front of either plunger.



THE CRAWFORD UNDERFEED LOCOMOTIVE STOKER AND ITS CONVEYOR.

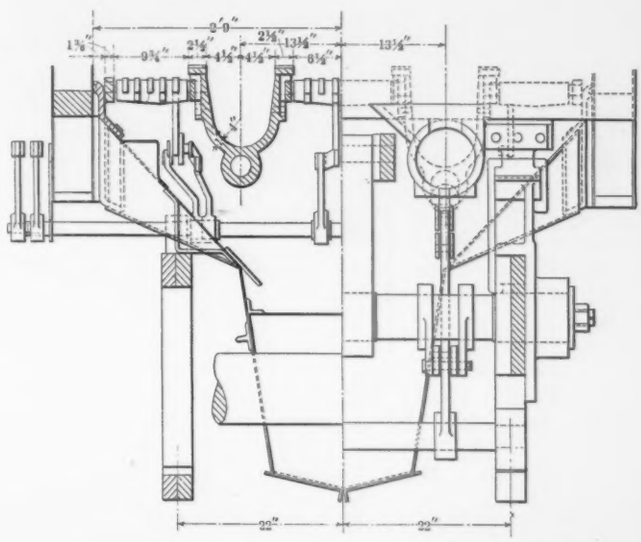


SECTIONAL ELEVATION OF CRAWFORD STOKER AND CONVEYOR. THE EXTREME SIMPLICITY IS VERY NOTICEABLE.

The conveyor while secured to the locomotive to prevent any movement in its relative position to the stoker is really a tender appliance and it is carried on the tender by means of a support arranged to give free movement in both the horizontal and vertical planes while at the same time maintaining its position in the proper relation with the loader. This is arranged by supporting the trough at a point about one-third the distance from the back end by trunnions resting in a casting, which is secured by means of a pivot to the tender frame at a point about 12 in. back of the conveyor support. The motion for the reciprocating fingers is arranged through a series of links so that the relative position of the engine and tender does not affect it.

Providing for a possible failure of the conveyor apparatus there are two small hoppers extending slightly above the deck level discharging in front of the main stoker plungers, through which coal can be shoveled and handled by the stoker in the regular manner.

In operation, the coal, crowded into the trough by means of the main plunger and carried forward and upward by the auxiliary plungers, rises up and flows over the edges of the trough onto the grates at either side. While there is a slight ridge



SECTION SHOWING SHAPE AND SIZE OF TROUGHS.

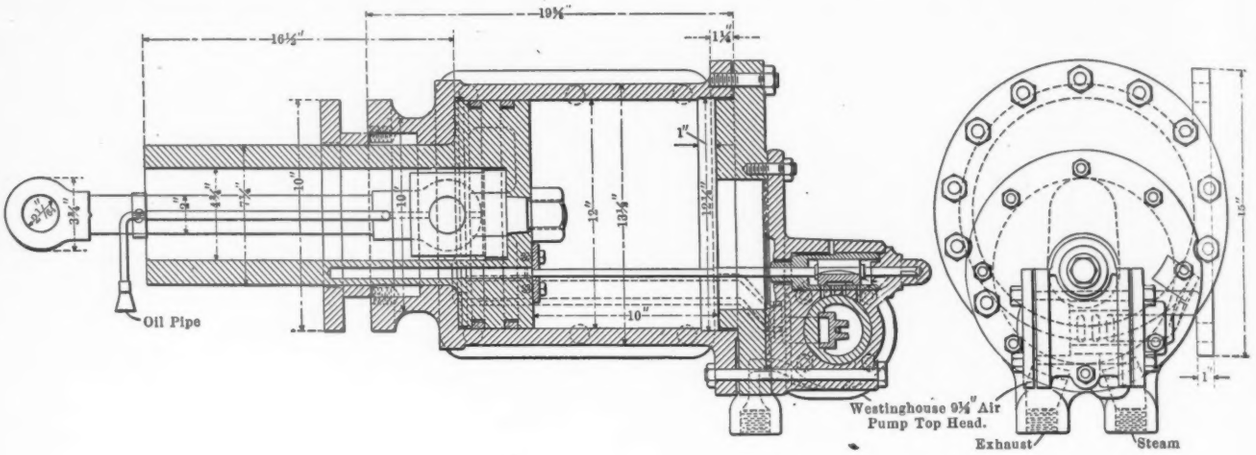
along the top of the troughs when in operation it is not as noticeable as might be expected, since the motion of the engine and the incline of the side of the trough tends to keep the fuel bed fairly level. The total air supply is, of course, obtained through the grates, but it is found that the air works its way through the coal on top of the trough, giving active combustion throughout the whole grate area. While it is possible to discover by means of a colored glass that combustion is not quite as rapid in the center over each trough there is no noticeable difference with the naked eye, and so far as area for combustion is concerned there is no loss by the introduction of the troughs. The reduction of the grate area might be expected to have an effect upon the air supply, but when it is remembered that in the ordinary construction there is generally a vacuum in the ash pan it will be seen that if proper openings in the pan are provided the openings in the grate will be more than sufficient. As a matter of fact, in practice and by tests it has been found that the introduction of the troughs has not interfered with a sufficient supply of air through the grates.

In starting, a fire is built in the same manner as with a locomotive without a stoker until sufficient steam pressure has been raised to operate the stoker engine. As soon as this is attained the stoker is started and is used for building up the fire in the roundhouse and continues in service until the end of the run. The grates are shaken on the road in the same manner as with-

out the stoker and fires are cleaned through dump grates in the front as usual.

It is occasionally necessary to use the hook in order to level off the fire the same as is done with hand firing. Carefully kept records show that the hook is used as often with the stoker as without, when run of mine coal is in use, but when coal having a large percentage of slack is fired it is necessary to hook the fire more frequently than when firing the same fuel by hand. While the hook is being used there is more or less smoke thrown off, but at other times the combustion is practically smokeless.

As an example of the results being obtained in service with the stoker the accompanying table, showing a number of recent trips of locomotives fitted with it, are given.



STOKER ENGINE USING A 9½-IN. AIR PUMP HEAD AND VALVE GEAR.

Locomotive number	8310	9383	7395	8462	8557	8604	8564	Totals and Averages
Class	H 6 b	H 6 a	H 6 a	H 6 a	H 6 b	H 6 b	H 6 b	
Dates, 1910 and 1911	9-15 to 3-26	10-14 to 4-3	12-5 to 4-4	1-2 to 3-3	1-3 to 4-5	1-24 to 4-4	2-28 to 4-5	
Total number of separate trips	199	202	103	117	76	59	20	773
Total mileage with train	19122	6451	2580	6000	7476	5495	1974	49.098
Average mileage per trip	96	32.3	31.2	94	98	93	98.7	63.5
Average tonnage per trip	1256	2096	2187.9	1386.5	2310.8	1401	1437	1725
Average speed, M. P. H.	24.2	17.	15.4	24.1	22.	23.5	24.3	21.5
No. times fire-hooked, average per 100% trips	11	3.1	2.2	7.2	9.1	6	6	6.8
No. times grates shaken, average per 100% trips	8.1	2	1.7	7.5	7.5	7	4	5.4
No. of trips with 100% stoker work	85	171	98	69	39	39	16	517
No. of trips with stoker work of over 90%	38	22		20	21	9	3	113
No. of trips with stoker work from 50% to 90%	61	7	3	20	10	7		108
No. of trips with stoker work less than 50%	15	2	2	8	6	4	1	38
Average per cent. stoker work	80.32	98	97	90.8	85.	94	99.5	92.1

An investigation of the detailed daily reports showing the causes of less than 100 per cent. stoker work from which the above table was made up, reveals the following general information:

LOCOMOTIVE No. 8310. This engine was the first to be equipped with a new No. 14 stoker, and as might be expected for the first few trips considerable difficulty was encountered. The first trip gave but 7 per cent. stoker work on account of coal packing solid in front of the ram. The next trip was 77 per cent. stoker work, and the following day was a 100 per cent. trip. On the fourth trip a pin was lost out of the conveyor, giving a 42 per cent. trip. The next one was a 70 per cent. trip on account of imperfect distribution because of clinkered coal. Following this trouble was encountered on the next two trips by the troughs choking up or the crusher clogging. On the next day there was a 100 per cent. trip, and on the next one poor coal and a clinkered fire gave a 40 per cent. trip. From that time on for practically a month the operation was almost perfect, a little difficulty being encountered occasionally with poor coal, giving a clinkered fire, necessitating some hand firing. Following this, clinkered fire gave more and more trouble and experiments were carried on to overcome it. In fact this difficulty continued for two or three months, during which time there was only an occasional 100 per cent. trip, but many of nearly 100 per cent., the clinkered condition of the fire requiring a little hand firing but the stoker doing practically all the work. About the beginning of February conditions improved and 100 per cent. trips became very frequent. Trouble with the stoker mechanism on this locomotive throughout have been very slight.

LOCOMOTIVE No. 9383. This engine was equipped on the 14th of October and gave very good results right from the start. On the fifth trip hand firing was resorted to on account of the conveyor saddle breaking. The following four or five trips gave some trouble with clinkered coal, which was soon corrected, and from the 8th of November to the 8th of February there were but nine trips of less than 100 per cent., all of these but one being over 90 per cent. stoker work, the cause of failure being poor coal and a slight uneven distribution, and in one case the crusher clogged and a 70 per cent. trip occurred. Beginning with the 8th of February there were a long series of 98 and 99 per cent. trips on account of the fire being light at the door. About the 1st of April slight trouble developed with the stoker mechanism, giving two or three poor trips.

LOCOMOTIVE No. 7395. Beginning with the 5th of December the stoker on this engine gave practically perfect service up to January 6th. In one case the stoker engine broke down, giving a 60 per cent. trip; in another case a 75 per cent. trip was caused by the stoker engine not being lubricated. On January 9th the stoker broke down, giving a 25 per cent. trip, and on the 13th the stoker engine stuck, giving a 10 per cent. trip. Following this, however, the perfect trips were continuous up to the 19th, when poor coal caused two bad trips, but from that time to the 4th of April the record is perfect.

LOCOMOTIVE No. 8462. From the time the stoker was installed on November 2nd, very successful results were obtained up to the 17th, when one of the auxiliary plungers stalled, putting the stoker out of commission for that trip. After this was repaired the record is very satisfactory up to December 19th, when a 29 per cent. trip occurred for some reason not quoted in detail. The average steam pressure on this trip was but 183 lbs. One hundred per cent. trips then followed up to the 28th, when the crusher opening became choked up and an 8 per cent. trip followed. For the next thirty days more or less trouble was incurred by poor coal, principally because of it being very fine, and a number of trips of 50 per cent. or less are recorded. The only trouble with the stoker mechanism was in connection with the steam cylinder. Following the 13th of February there was one occasion where one of the rams gave trouble, and some trouble with lubricating the steam cylinder. On March 22 a stoker engine piston broke, and on the 31st two rams stuck fast in the troughs.

LOCOMOTIVE No. 8557. The stoker on this engine, which was applied on the 3rd of January, gave comparatively few 100 per cent. trips, principally on account of poor coal, although the mechanism itself was subject to a number of accidents, some of these enumerated being: broken crusher stud, crusher choked, connector bolt loose, stoker engine piston head loose, stoker engine out of order, stoker stalled, large lump caught in crusher, main stoker shaft key lost, and slack coal stalled conveyor. The average percentage of stoker work on this engine for the seventy-six trips recorded is but 85 per cent.

The following two engines, one of which was equipped on the 24th of January and the other on the 28th of February, have given very excellent results up to date. The difficulties that have occurred have been principally due to clinkering and fine coal.

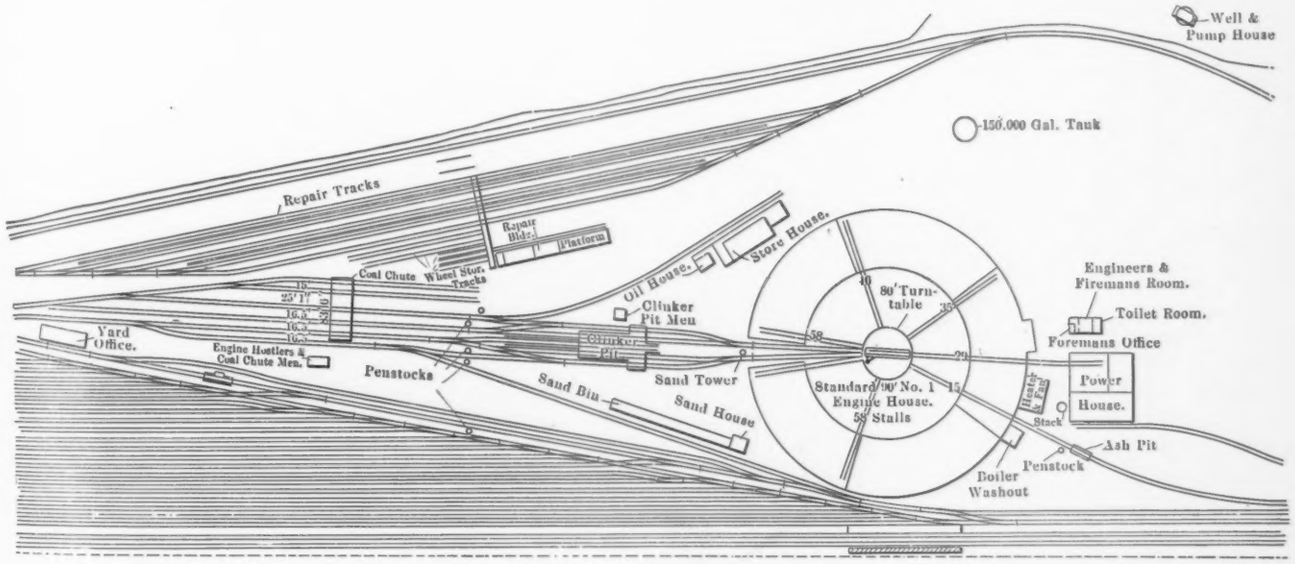
The record of these seven engines, covering 773 separate trips, and mileage with train of about 50,000 miles, gives an average per cent. of stoker work of 92.1 and a percentage of perfect trips of 67 per cent.

Locomotive Terminal at East Clinton, Ill.

CHICAGO & NORTHWESTERN RAILWAY.

IN CONNECTION WITH THE LARGE YARDS ON THE EASTERN SIDE OF THE MISSISSIPPI RIVER OPPOSITE TO CLINTON, IA., WHICH THE CHICAGO & NORTHWESTERN RAILWAY HAS RECENTLY CONSTRUCTED, A LOCOMOTIVE TERMINAL FOR FREIGHT ENGINES, CONSISTING OF A FIFTY-EIGHT STALL ROUNDHOUSE AND AUXILIARIES TO SUIT, HAS BEEN BUILT.

In 1900 the Chicago & Northwestern Railway erected at Clinton, Ia., a new 50 stall roundhouse, replacing an older and similar structure at the same point,* the layout being so planned as to provide for another roundhouse of the same size when needed. Since that time, of course, traffic has greatly increased and necessarily the number of cars handled has increased more rapidly than the number of locomotives, and when it was found imperative to greatly enlarge the existing yards the decision was made to build entirely new yards across the river from the present terminal and transfer all freight traffic to that point, therefore the original plan at Clinton has not been carried out and an entirely new locomotive terminal has been constructed



GENERAL LAYOUT OF FREIGHT LOCOMOTIVE TERMINAL AT EAST CLINTON, CHICAGO AND NORTHWESTERN RAILWAY.

in connection with the new yards and at this point all freight engines will be taken care of, leaving the present 50 stall house for passenger service only.

For the purpose of facilitating the movement of locomotives as much as possible the new terminal has been located at a convenient point near the center of the yards, so that locomotives going to or coming from the roundhouse will require a minimum amount of switching and a minimum distance to travel. It is planned to have all incoming and outgoing engines handled from the western side of the roundhouse, although a single exit and entrance track has been provided on the eastern side, being equipped with a small ash pit and water crane. A study of the general layout will show that there are two tracks coming from the yard which branch into four tracks before reaching the coal chute, on any one of which coal can be taken. These four tracks continue over the cinder pit and then combine into two tracks, which are continued to the turntable. The two inner tracks of the four are intended for incoming engines and are served by cinder pits 102 ft. in length. The outer two tracks are intended for outgoing engines and have a small cinder pit, being an extension at the side of the longer one, arranged as is shown in the plan. Crossovers are provided between the first and second and third and fourth tracks, so that incoming engines can be run around those that may be on the pit and brought into the house more quickly. A branch from the southerly track, being taken off between the coal chute and cinder pit, permits a reverse movement eastward for engines going to that end of the yard. The water cranes are located about midway between the coaling station and cinder pit and all sanding is done at the sand tower just before going on to the turntable

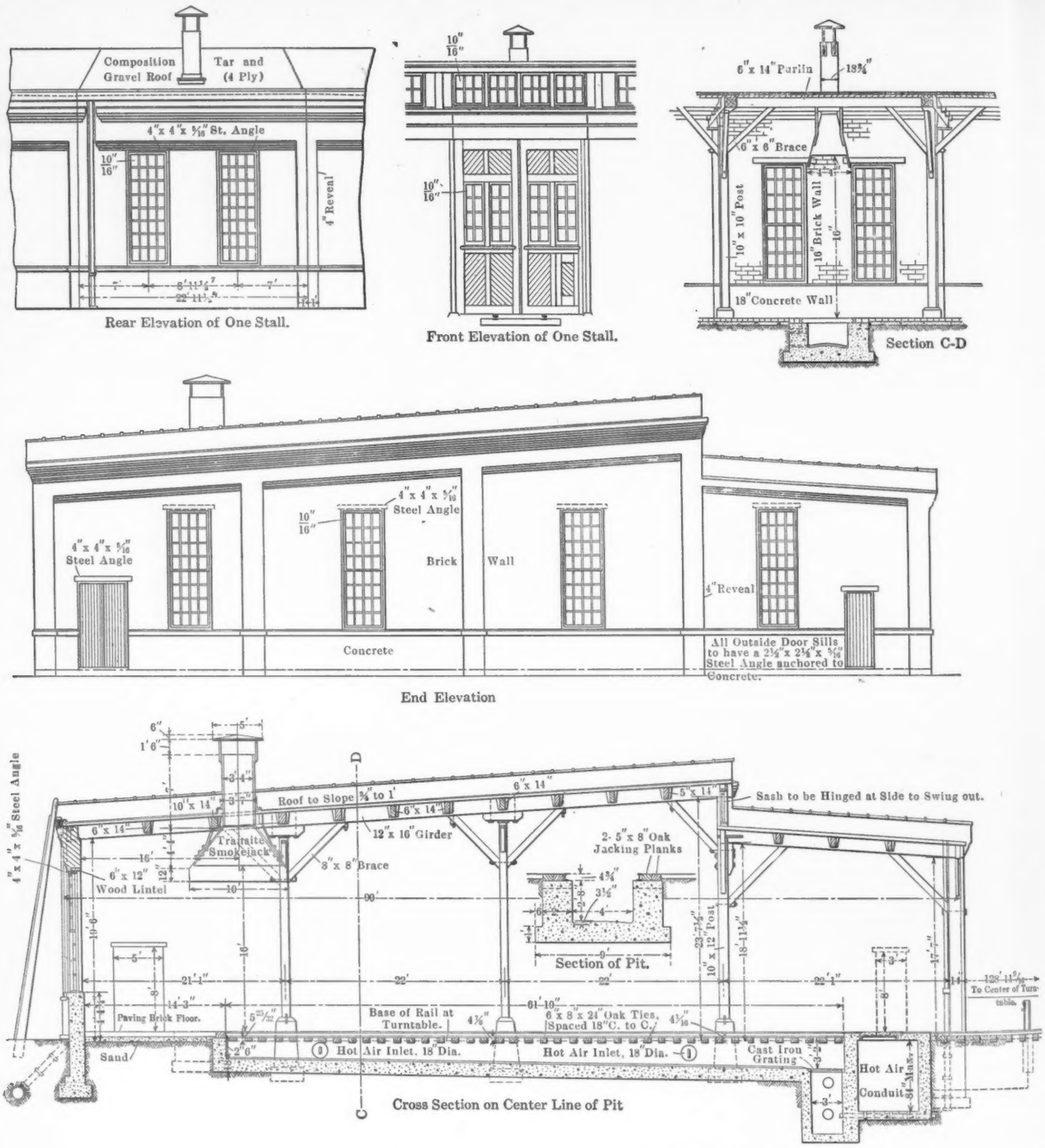
Other buildings in connection with the terminal consist of a large structure 100 x 110 ft., which houses the machine shop, the blacksmith shop and powerhouse; it is located just to the east of the roundhouse. Adjoining this is a small brick building containing the engineers' and firemen's rest and wash rooms, foremen's office, etc. On the other side of the roundhouse is the store and oilhouse, in separate buildings, and beyond are tracks for car repairs, with a small shop for wheel and blacksmith work. The whole terminal is well grouped, the total distance from the coaling station to the powerhouse being but about 1,200 feet.

ROUNDHOUSE.

The roundhouse measures 90 ft. between walls and the inner circle has a radius of about 129 ft. The 58 stalls in the house, with the two entrance tracks, give an angle between tracks of 6 degs. Since the turntable is 80 ft. in diameter this requires the use of frogs around the turntable circle. The distance between the center of the tracks at the outer wall is 22 ft. 11½ in. and at the inner wall 13 ft. 6 in. The house is divided into five sections by four fire walls, giving three sections with 12 tracks each and two with 11 tracks. Doors are provided in the fire walls at both the outer and inner circle.

Following the standards of the company for roundhouses, the building consists of a concrete foundation carried up to the level of the window sills and a brick outer circle and end walls above the window sills, with a simple design of wooden roof. The distance from the floor to the underside of the roof timbers at the outer wall is about 19 ft and from this point the

* See AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1901, p. 25.



ELEVATIONS AND SECTIONS OF STANDARD 90 FT. ROUNDHOUSE—C. & N. W. RY.

roof slopes upward at an angle of about ¾ of an inch to the foot for a distance of 55 ft., where a series of vertical windows are inserted and a drop of about 5 ft. is made when it slopes downward to the inner circle, giving a distance of about 17 ft. from the bottom of the roof timbers to the rail at the doors. This type of roof and general arrangement has been found to be entirely satisfactory in giving good ventilation and lighting. The smoke jacks are located about 16 ft. from the outer wall and do not provide an opening for ventilation around the outside of the vertical pipe. They are carried up about 6 ft. above the roof level and provided with hoods and dampers, as is shown in the illustration. The roof is covered with a four-ply composition tar and gravel roofing and the gutters are arranged to drain through down spouts on the inside of the house at the inner circle and outside of the walls at the outer circle. The vertical sash in the roof is hinged to swing outward.

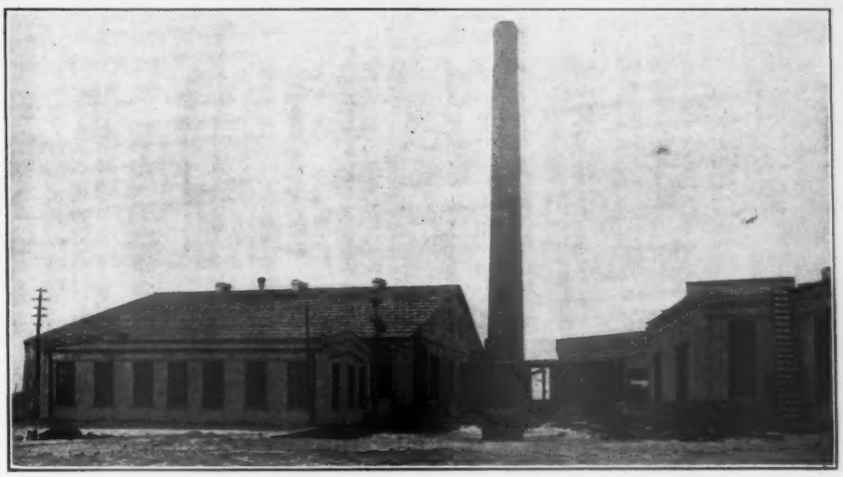
An inspection of the illustrations show that the window area while carried to a good height is not as large as has been customary in other terminals or as would have been easily possible. There are two narrow windows opposite each pit in the outer circle and about one-third of each door is given up to lighting area, this in connection with the four swinging sash in the roof, about 4 ft. in height, constitutes the whole natural lighting area, giving a total of 134 sq. ft. per pit.

Transit board smoke jacks, with an opening at the bottom of 4 ft. 4 in. x 10 ft., narrowing up to a cylindrical section 3 ft. 4 in. in diameter, are installed over each pit. With the ordinary consolidation locomotive when its stack is under the center of the jack the pilot will be about 7½ ft. from the wall. These smoke jacks are arranged with 16 in. wings extending down on the sides, the ends being 16 ft. above the rail. They are supported directly from the roof timbers without any special construction.

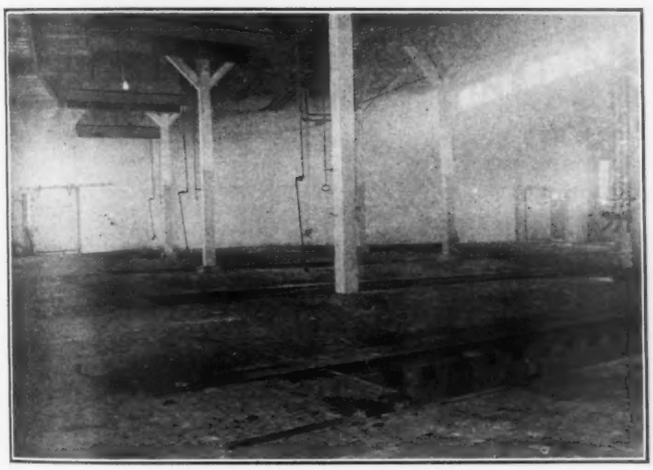
One of the illustrations shows cross sections of the pits, which are of concrete 12 in. thick at the bottom and 2 ft. thick at the sides, having a slope, relative to the rail level, of 8 in. in their

length of 61 ft. 10 in. They drain toward the inner circle, there being a deep concrete sump covered with a cast iron grating at the inner end of each pit. The depth at the front is 2 ft. 10¾ in. from the top of the rail. The rail itself, and in fact the whole floor of the roundhouse, has a slope toward the inner circle of about 5 in. in its length, this grade being continued to the turntable pit. The pit rails are carried on sections of oak ties spaced with 18 in. centers embedded in the concrete, which is carried up flush with the top of these ties and capped by two 5 x 8 in. jacking planks on the outside of each rail.

Heating System.—Hot air is used for heating, the same as was installed in the roundhouse built eleven years ago, although in that case the ducts were carried overhead and in the present case they are built of concrete around the inner ends of the pits. In an addition on the outside of the house opposite the entrance track, which measures 40 ft. x 56 ft. 6 in., are installed a duplicate set of Sturtevant fans with coils, each being driven by a 75 h.p. G. E. induction motor. Each fan discharges into a conduit measuring 70 by 84 in., which serve one-half of the house. These conduits grow smaller in size until at the end



GENERAL VIEW AT EAST CLINTON SHOWING CHARACTER OF STRUCTURES.



INTERIOR OF ROUNDHOUSE.

they measure 48 in. x 48 in. in section. Between each alternate pair of pits is carried off a section 30 x 24 in. which branches out and discharges through two 18 in. openings fitted with dampers along one side of each pit. Large dampers are, of course, fitted in the main conduits near the fans, and the coils are arranged in groups so that the necessary amount of heating surface can be employed without waste. Exhaust steam is sufficient for ordinary purposes. The matter of drainage of this hot air conduit has been carefully considered and the whole heating system is reported to be very satisfactory. The top of the conduit forms a concrete walk around the inner circle and doors are cut in the fire wall so that this passage can be freely used.

Lighting.—Artificial lighting is entirely by incandescent lamps which are carried from the roof timbers, the wiring being carried in iron conduits and each group of lights between pits being controlled by a switch on the outer wall.

In the section of the house nearest the machine shop there are two drop pits, one for driving wheels, serving two pits, and the other for truck wheels, serving the next two pits. The driver pit is 7 ft. 10 in. in width and is provided with a telescopic air jack.

The floor is of paving brick laid on the sand, being well crowned to drain into each pit. The end of the pit rails are not provided with stops.

Benches for workmen are located along the outer wall wherever necessary.

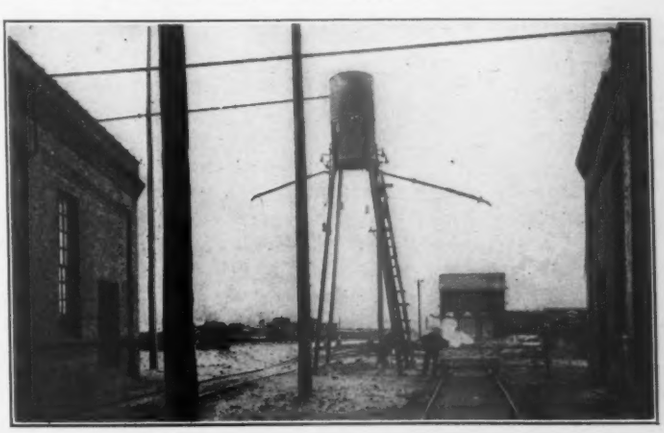
Boiler Washing System.—The hot water boiler washing and changing system installed by the National Boiler Washing Co. of Chicago is its standard apparatus. The pipes are carried around the center of the house from the roof timbers, the connections coming down on the center posts between each alternate pit. The pumps and tanks are located in a small addition just outside of the roundhouse wall, adjacent to the power house. This system and arrangement has been fully illustrated and described in these columns.*

An 80 ft. turntable equipped with an electric tractor has been provided. The turntable was built by the American Bridge Company and the tractor was furnished by George B. Nichols & Bro. The walls of the pit are of concrete, but the bottom is not paved, since the sandy soil in that locality gives good drainage and requires no covering. The electric circuit is carried through an underground conduit to a commutator at the center pin.

CINDER PIT.

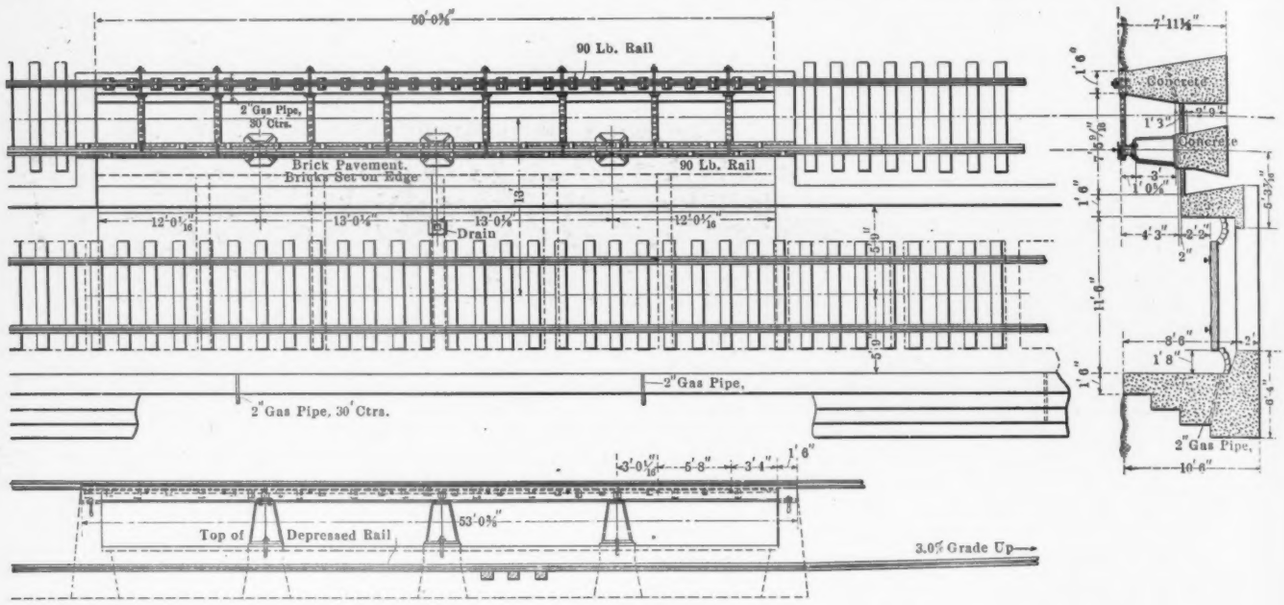
The standard cinder pit of the Chicago & Northwestern Railway has been installed at Clinton. In this case it consists of two pits 102 ft. long, with a depressed track between them, and two short pits, 23½ ft. in length, for dumping the ash pans of outgoing locomotives. The pits are constructed of concrete with the outside rail resting on the wall and the inner one being supported on a steel girder resting on cast iron chairs on a concrete foundation located at about 13 ft. centers. The steel girder carrying this rail consists of two 15 in. channels set 6⅛ in. apart, the rail being supported upon a 6 x 4 in. angle riveted to one of the channels, this in turn being reinforced by a 5 x 3½ in. angle secured to the other channel. The bottom of the rail is 2⅜ in. below the top of the channels, the space between being filled with asphalt mixture, and the rail is held in place by malleable iron clips arranged as is shown in the illustration.

* See AMERICAN ENGINEER, Dec., 1910, page 469.



VIEW OF SAND TOWER AND ENTERING TRACKS.

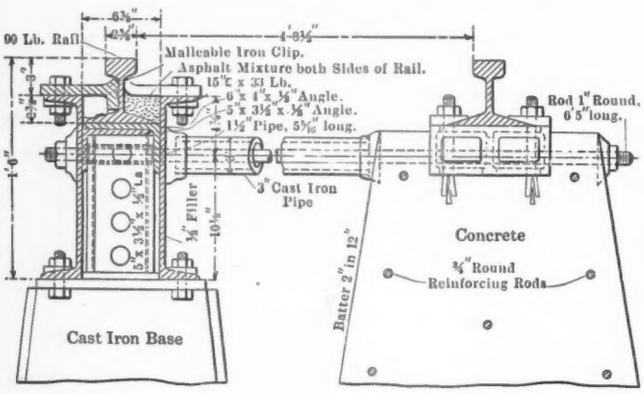
The stiffening and spacing bars between the two rails are protected by a 3 in. cast iron pipe. The depressed track is set at 13 ft. centers from the cinder pit track, which gives a wide platform for the shovelers. The floor of the pit is of brick resting on concrete The concrete construction and general arrangement of the pits is clearly shown in one of the illustrations. A brick building 14 ft. square is provided near the pits for the use of the men.



STANDARD ASH PIT OF THE CHICAGO AND NORTHWESTERN RAILWAY.

SHOPS AND POWERHOUSE.

The building containing the powerhouse and shops is a brick structure with steel roof trusses and tile roof and conforming in its excellent exterior appearance with the roundhouse and other buildings. The small machine shop occupies a space of about 50 x 65 ft. in one corner of this building, which has been provided with a floor of creosoted wooden blocks. The tools are belted from a line shaft which is driven by a 35 h.p. G. E. induction motor located in the engine room adjoining. A track



DETAIL OF C. & N. W. ASH PIT.

extends into the machine shop from one of the pits in the roundhouse.

At the present time there has been installed in the machine shop, two lathes, a planer, shaper, double headed boring mill, drill press, punch and shear, bolt cutter, hydraulic press and emery wheel. A motor driven wheel lathe is to be installed in the near future.

A small blacksmith shop has been provided in an unused part of the boiler room.

In the boiler room of the powerhouse there have been located five 150 h.p. fire tube boilers carrying a working pressure of 125 lbs. The draft is furnished by a brick stack 125 ft. in height. The engine room contains two alternating current generators, each driven by a Russell 20 x 20 in. single cylinder engine. The generators have a capacity of 250 k.w. each. A duplex air compressor is also provided in the same quarters.

COALING STATION.

As is mentioned above, the coal chute is arranged to serve four tracks, three passing underneath the storage bins and one at the end. This station is of 800 tons capacity of the double balanced elevator type, built by Fairbanks, Morse & Company. The conveying apparatus is in duplicate and is arranged to both elevate and transport horizontally. The conveyors are driven by a 20 h.p. induction motor.

WATER SUPPLY.

The water supply is taken from the Mississipii River, on the banks of which are two three-plunger vertical pumps, each driven by 25 h.p. induction motors, discharging into a large steel tank of 150,000 gallons capacity, which furnishes the pressure and storage for the whole terminal.

SUPERHEATERS ON LONDON & NORTHWESTERN RAILWAY.

On page 101 of the March issue of this journal, the experiments which the London & Northwestern Railway were making with superheaters were mentioned as being one of the most thorough and important tests of this kind that had ever taken place. It was there stated that the superheater being used was very similar to the Schmidt. We have been informed that this superheater was actually of the Schmidt design and the results of these tests have been such as to lead the London & Northwestern Railway to order 100 superheaters from the Schmidt Company for immediate application.

THE NEXT ANNUAL CONVENTION of the International Master Boiler Makers' Association will be held at Omaha, Neb., on May 23, 24, 25 and 26. The Rome hotel has been chosen as official headquarters. H. D. Vought, 95 Liberty street, New York, is secretary.

THE EIGHTH ANNUAL CONVENTION of the Railway Storekeepers' Association will be held at Hotel Pfister, Milwaukee, Wis., May 22, 23 and 24, 1911. Correspondence and inquiries should be addressed to J. P. Murphy, secretary-treasurer, Box C, Collingwood, O.

JIG FOR SETTING ECCENTRICS

AMERICAN LOCOMOTIVE CO.

The location and subsequent cutting in the axle of eccentric keyways in connection with engines equipped with the Stephenson link motion has always been a very troublesome operation, and one which has uniformly constituted the source of much delay in the erecting shop. Under the plan generally followed the wheels are transferred to that department with the eccentrics merely tightened in approximately their correct position by the set screws, and the keyways are not laid out until the valve setting procedure is finally complete This, of course, implies that the axle must be drilled and chipped in very narrow confines under the locomotive in which to work, and in view of the obstacles in the way which need not be enumerated, fifteen hours is not considered ordinarily as an excessive length of time to devote to the job.

This time-honored method, however, laborious as it may be, has the merit of insuring absolute correctness in the setting of the eccentrics and immunity from "lipped" or offset keys, the latter being a very important consideration now that the eccentrics have become so heavy and the shearing stress on the key has greatly increased. It is for the sake of securing this exactness in location that the plan of keying on the eccentrics as the last detail in valve setting has been so long adhered to, and despite the fact that many ingenious means have been devised to locate them before the wheels go under the engine they have not been received with any particular favor because of the liability to error which all of them embody in varying degrees.

Railroad repair shops in practically every instance follow the old plan, and as main axle renewals are comparatively infrequent in locomotive maintenance, these shops are not greatly embarrassed by delay, notwithstanding the cumbersome nature of the work. In the instance of the locomotive builders, however, the matter assumes a much more serious phase, and it becomes almost imperative that the wheels should leave the machine shop with eccentrics mounted and keyed on the axle, and with their straps applied ready for the blades.

In some instances twenty engines of uniform design may be erected simultaneously and the inconvenience to the erecting department in removing eighty eccentrics, cutting an equal number of keyways and reassembling the parts may be imagined. It may be also well to recall that no matter how extensive such an erecting department may be, there is usually only one valve setting gang available for the work.

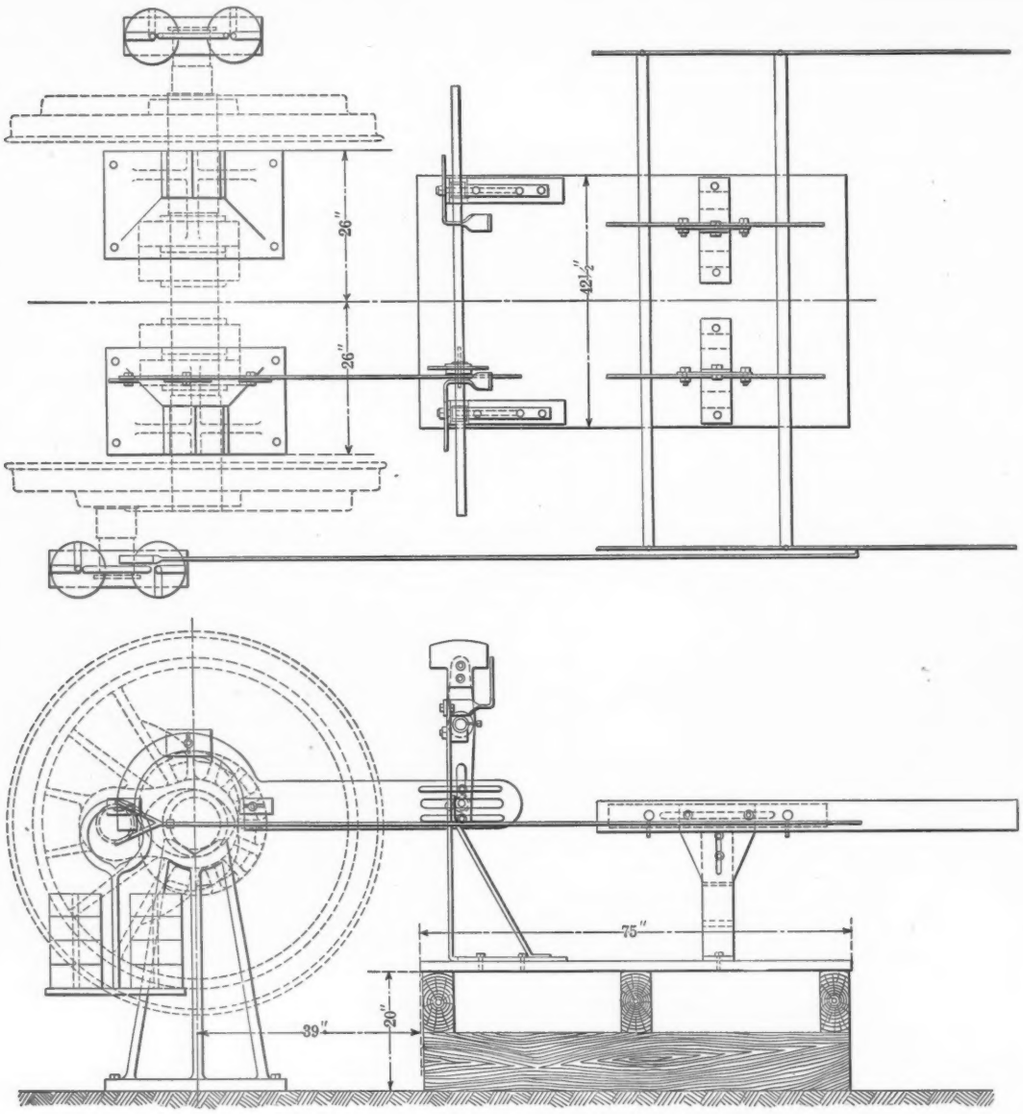
Probably the most effective device for properly locating eccentrics in the machine shop is that herein illustrated. It is in daily use at the Cooke Works of the American Locomotive Company, in Paterson, N. J., and the results attained are truly remarkable. On one occasion a record was kept of eccentrics located on fifty engines, and in this total, representing 200 keyways, it was necessary to offset only one key, and that but one-sixteenth of an inch.

AN INGENIOUS DEVICE FOR LOCATING ECCENTRIC KEYWAYS.

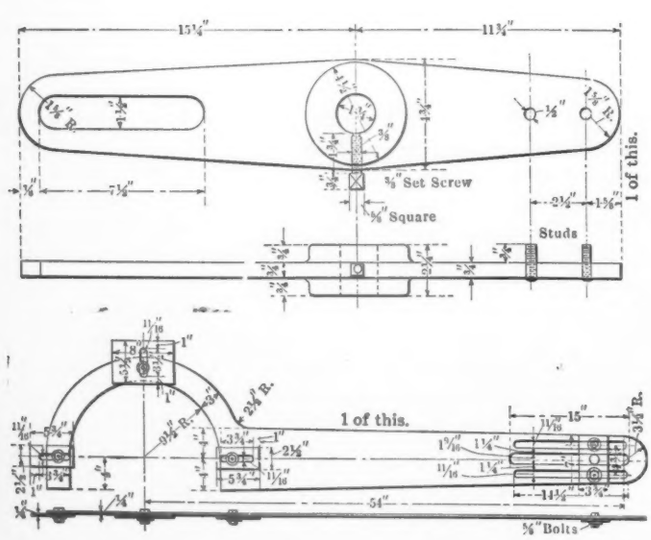
Although one of the least known of the American Locomotive Company's various branches, the Cooke Works has in the past numbered some of the most resourceful mechanics on its roster that the country has produced. It was famous a decade ago for the labor-saving devices and methods for doing work, and many of these appliances are still in use, notwithstanding the radical transformation in power which has characterized the intervening period. It is believed that the first set of eccentrics were keyed on in this plant without the preliminary of valve-setting. This was in the instance of an engine with 24 in. stroke, 5 in. maximum valve travel, ¾ in. outside lap, ⅛ lead, and with both rocker arms the same length, which latter was universal practice at that time. These eccentrics were set merely by measurement, the wheels being placed on the forward center for the side being worked on, and the forward motion eccentric advanced from its right angle position with the pin a distance equal to the sum of the lap and lead. The success which extended this departure from the former time-honored method resulted in the development of the elaborate jig for setting eccentrics which is now in use at that plant.

It will be noted from the illustrations that the device practically reproduces all conditions on the locomotive to which the wheels are to be applied. To this end it is made adjustable in every detail, which will be observed in connection with the

drawing of the rocker arm and the eccentric rod. The wheels are placed by the crane on the supporting blocks and the counterweights properly balanced to permit easy turning. The eccentrics, of course, are temporarily secured in approximately the correct position and the wheel centers are marked on the long slide index which may be chalked for ready reference. The prints of the motion indicate the amount of lap and lead desired, and all can be faithfully reproduced in the jig by means



GENERAL ARRANGEMENT OF ECCENTRIC SETTING DEVICE.



ADJUSTABLE ROCKER AND ECCENTRIC ROD.

of trams. The general procedure is so similar to actual valve setting on the locomotive that no extended description is necessary.

The contrivance is thoroughly practical, and is of inestimable value in cases where a long run of this particular work is in order. It restricts the erecting shop valve setting to the mere adjustment of the eccentric rods, and the cutting of the keyways is resolved into a very simple matter through their accessibility with the wheels on the floor of the shop. While wheels are in the jig the entire manipulation of the latter can be effected by a single operator.

VANDALIA ACCIDENT RECORD.—Records just compiled by the Vandalia Railroad Company show that in 1908, 1909 and 1910 not one passenger out of a total of 9,800,030 carried was killed in a train accident on that railroad. The Vandalia Railroad operates 923 miles of line, though it has in all 1,716 miles of track. Its passenger trains have traveled a total of 7,665,479 miles in the past three years, carrying 330,348,935 passengers one mile, and not a single passenger was killed. Counting all passengers injured in the three years, however trivial, there were only 67.

Maximum Power Locomotives 2-10-10-2 Type

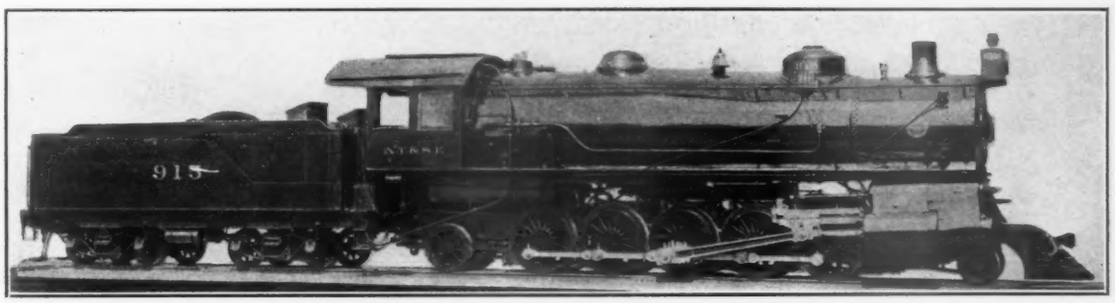
M. H. Haig.*

A practical assignment of power provides not only for the selection of locomotives capable of handling maximum trains over the divisions to which they are assigned, but also includes the grouping of locomotives of a single class in order that the largest number of engines may be served by the smallest number of repair parts carried in stock.

A desired increase in the tonnage hauled in single train units introduces the question of reducing existing grades or of providing locomotives of greater capacity since increasing the power by double heading is undesirable for many reasons. Not only is the investment in locomotives unduly increased where double heading is resorted to, but the cost of operation and the cost of maintenance is also increased. The greater cost of such maintenance and operation, as well as the costs of grade reductions, relocation of right of way via lower grade routes, etc., are being converted by the addition of front units to locomotives of the 2-10-10-2 type which have a total weight without tender of 616,000 lbs.

The original locomotives were built in 1902 by the Baldwin Locomotive Works and the front sections have just been completed by the same builders according to the railway company's specifications. The work of conversion is being done in the company's shops at Topeka.

The original locomotives are designated in the Railway Company's classification as the 900 and 1600 classes. The locomotives of these classes are tandem compounds having cylinders 19 in. and 32 in. by 32 in., and operate under a steam pressure of 225 lbs. The drivers are 57 inches in diameter and the tractive effort is 62,800 lbs. Those operating west of Winslow, Arizona, are in oil burning service, while those assigned



TYPE OF LOCOMOTIVE CONVERTED TO MALLETS. THESE ARE THE MOST POWERFUL LOCOMOTIVES EVER BUILT WITH A SINGLE SET OF DRIVERS.

point to the use of the Mallet locomotive as a means of hauling large tonnage without corresponding increase in cost of operation.

It has been demonstrated that locomotives now in service can be converted to the Mallet type at compatatively low expense. This can be done by the addition of front sections to existing locomotives, establishing maximum tractive units and disposing of the old power without the loss incident to scrapping locomotives which are still in good condition, though too light for the service required of them. The conversion of the old engines has the further advantage of providing greater power units which will still be served by the repair parts already carried in stock and the expense of building new patterns and introducing additional castings of new design, is eliminated.

During recent years a few railways have converted some of their locomotives to the Mallet type by the addition of a front unit or section to each locomotive converted. This additional section has included a forward tubular boiler section or feed water heater, a pair of cylinders, a set of connected driving wheels, etc. The locomotives converted have usually been of the consolidation type, though others, for instance the Prairie type, have been included. The records of the locomotives converted indicate successful operation and other roads are investigating the practice.

The most novel undertaking of this nature, however, has recently been performed by the Atchison, Topeka and Santa Fe Railway. In 1902 the Santa Fe Railway introduced a 2-10-2 type of locomotive† weighing 287,240 lbs., having a tractive effort of 62,800 lbs. and known as the Santa Fe type. This type was and still is the largest and most powerful locomotive operating on a single set of driving wheels. Now ten of these to territories east of this point are equipped to burn coal.

The Santa Fe (2-10-2) type locomotive has proved very satisfactory in heavy freight service, especially in mountain districts. No difficulty has been experienced with the long wheel base and with trucks at each end, the locomotive takes curves well, both going forward and backing up. After converting ten of these locomotives to the Mallet type, there will be 151 of the Santa Fe type still in service.

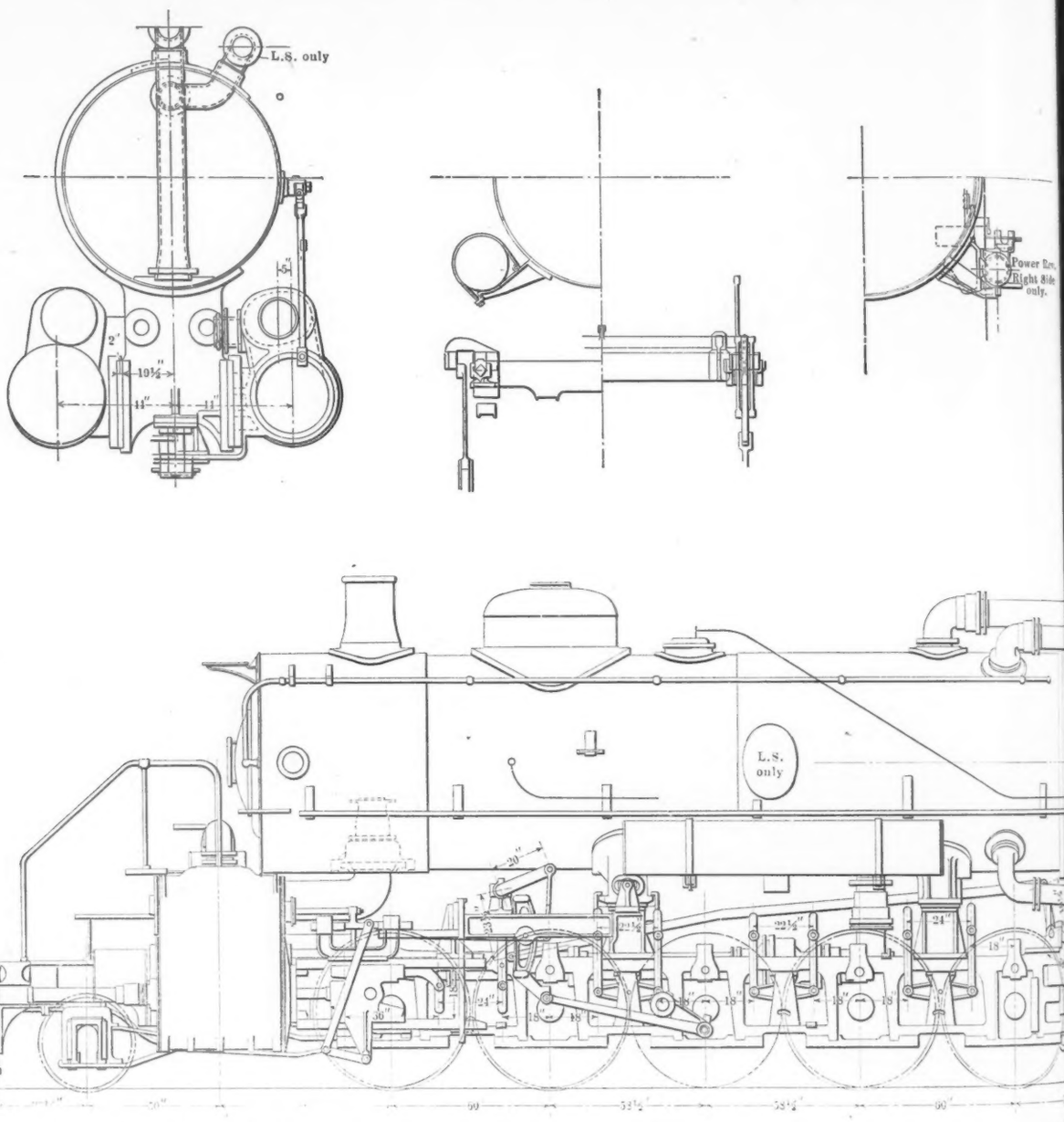
For conversion, ten locomotives were selected which required new fireboxes and general repairs. These were forwarded to the shops at Topeka, where they have been thoroughly overhauled and the necessary changes made for the application of the front sections. While making repairs, the original low pressure cylinders were bushed from 32 inches to 28 inches in diameter to constitute the high pressure cylinders of the Mallet locomotive. In renewing fireboxes the old box of each locomotive was replaced by a firebox of the Jacobs-Shupert type.* In applying new boxes the length of flues remained the same, but the firebox heating surface was increased from 209 square feet to 294.5 square feet, an increase of 40 per cent.

The front section is mounted on a two-wheel leading truck and ten driving wheels. The truck is of the same design as that under the original locomotive and the driving wheel centers are arranged at the same distance as on the original locomotive. The front boiler section includes a feed water heater 106⅞ in. long, located next to the smoke arch, and a superheater 95 7/16 inches long. Between the feed water heater and the superheater is a working space 32 inches long. Access to this working space is provided by a manhole in the shell. The shell of the boiler constitutes the shell of the feed water heater. The heater consists of a set of horizontal flues supported by two flue sheets which are riveted to the boiler shell. Water from the branch pipes passes around these flues, being heated to a

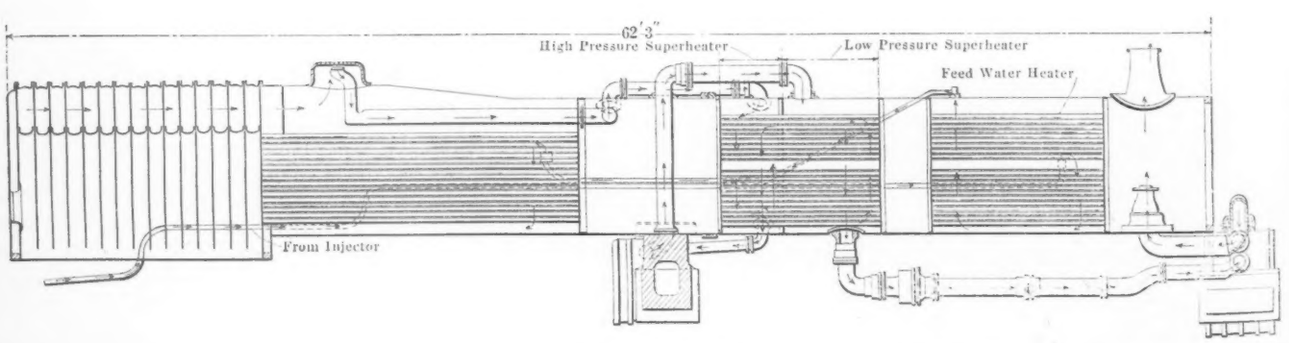
*Mechanical Engineer, A., T. & S. Ry. System.

† See American Engineer, Oct., 1903, page 372, and Nov., 1903, page 399.

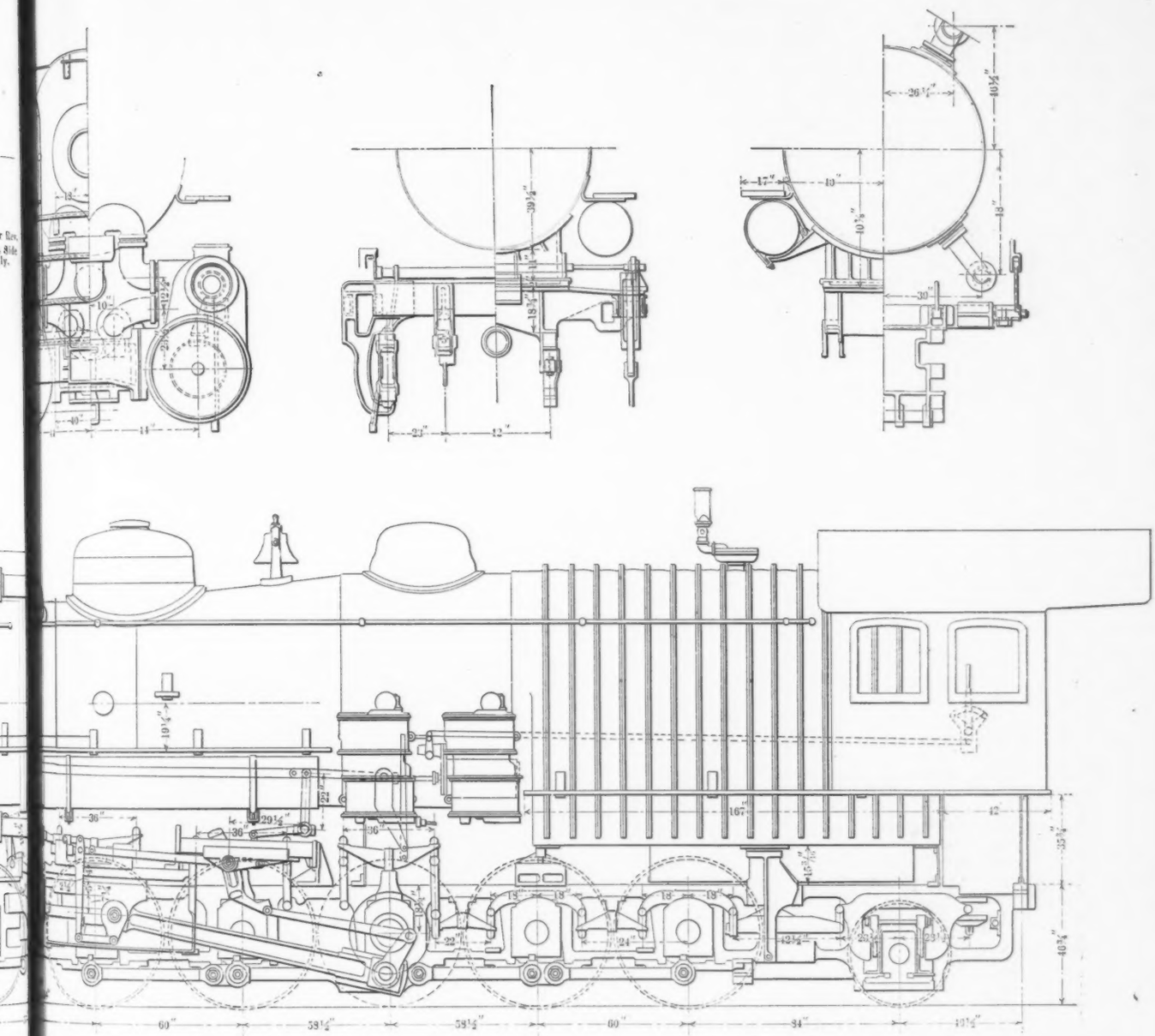
* See American Engineer, Mar., 1909, page 106.



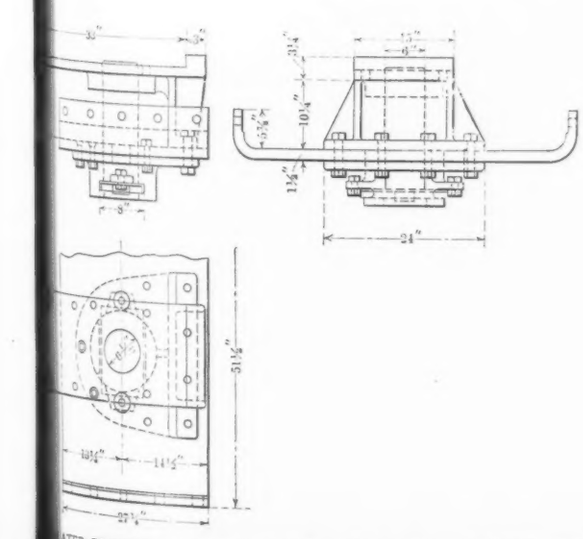
GENERAL ELEVATION AND SECTIONS OF THE LARGEST AND MOST POWERFUL LOCOMOTIVES IN THE WORLD. THE TOTAL WEIGHT OF EN... AND



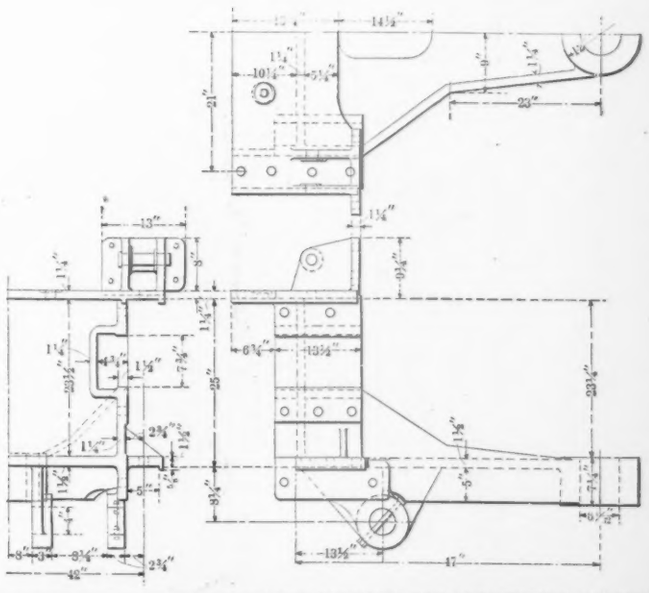
SECTION OF BOILER SHOWING JACOBS-SCHUPERT FIREBOX, BUCK-JACOBS SUPERHEATER AND REHEATER AND THE VERY LARGE FEED WATER HEATER.



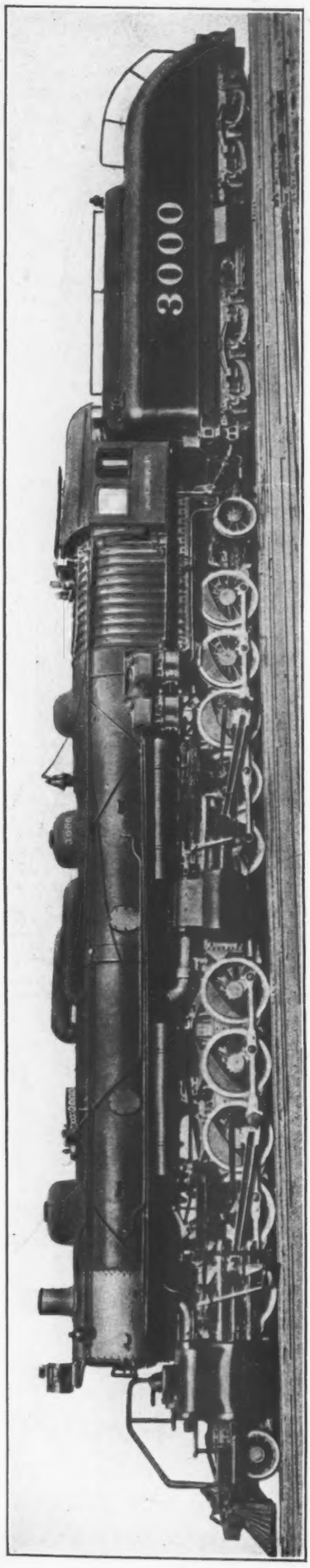
AND WITH TENDER IT IS 850,000 LBS. THEY ARE BEING CONVERTED FROM SANTA FE (2-10-2) TYPE LOCOMOTIVES AT THE TOPEKA SHOPS.



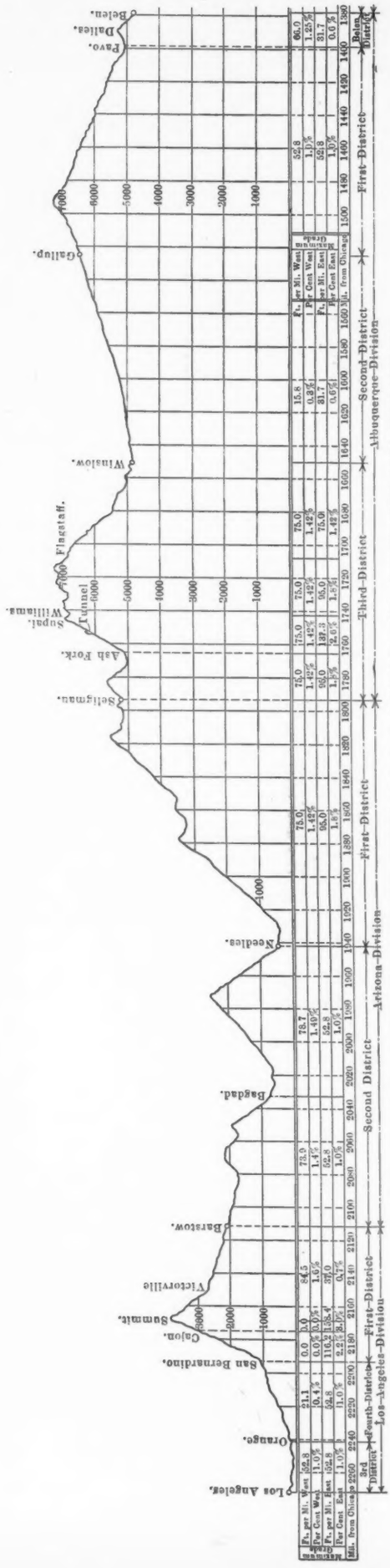
ATED JOINT CONNECTION AT THE HIGH PRESSURE CYLINDERS.



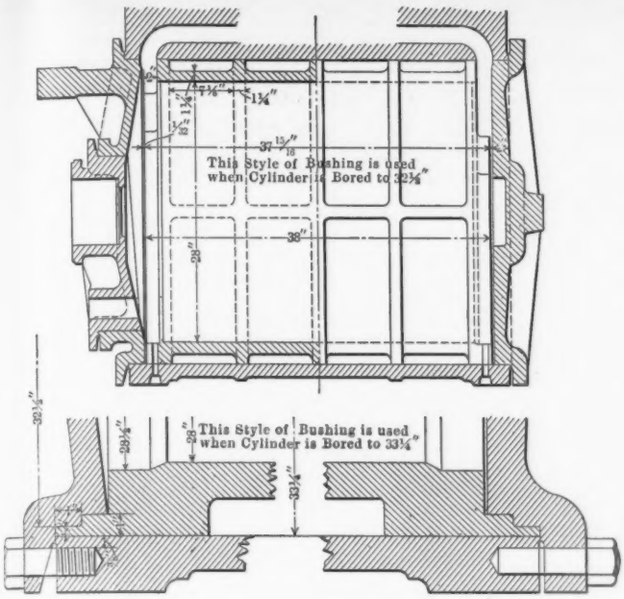
CASTING ON THE FRONT FRAMES FORMING THE CONNECTION AT THE ARTICULATED JOINT.



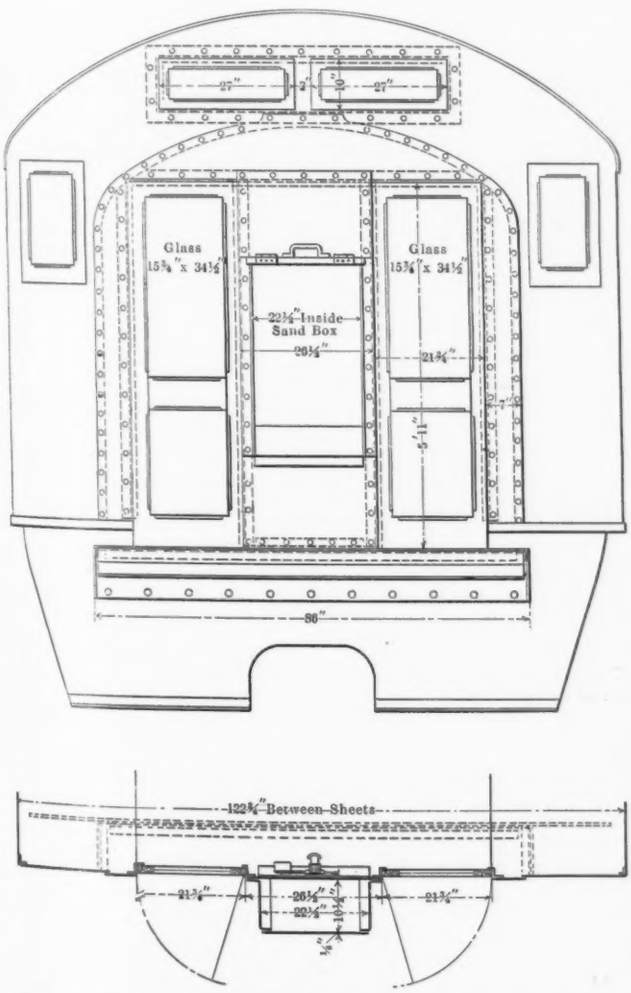
GENERAL VIEW OF THE LARGEST LOCOMOTIVE EVER BUILT.



PROFILE OF SECTION OF THE SANTA FE OVER WHICH THE NEW 2-10-10-2 TYPE LOCOMOTIVES WILL BE OPERATED.



METHOD FOLLOWED IN BUSHING THE LOW PRESSURE CYLINDERS OF THE TANDEM COMPOUND TO FORM THE HIGH PRESSURE CYLINDERS OF THE MALLET.



REAR OF CAB SHOWING METHOD OF ENCLOSING FOR PROTECTION IN RUNNING BACKWARDS.

temperature of about 245 degrees before entering the feed pipe leading to the boiler.

The superheater is of the Buck-Jacobs type.* It consists of a single drum in which the shell is integral with the shell of the boiler. The heads are riveted to this shell and support a set of horizontal flues through which the gases pass on their way from the firebox to the smokestack. An intermediate head divides the superheater into two sections, one in which saturated steam is superheated before entering the high pressure cylinders and a second, and larger, section in which exhaust steam from the high pressure cylinders is reheated before passing to the low pressure cylinders.

The boiler portion of the front section is attached to the former smoke arch of the original locomotive by a separable ring. One section of this ring is riveted to the old smoke arch and the other section is riveted to the new shell just back of the superheater. The joint in the ring is "V"-shaped and the two sections are secured together by horizontal bolts.

In preparing for the articulated joint between the two sections, the front frame rails of the original locomotive were cut off 23½ inches in front of the cylinders. The stub ends of these rails fit loosely between the rear ends of the frame rails of the forward section, according to the usual practice of the Baldwin Locomotive Works in connecting the sections of Mallet locomotives.

The hinge pocket for the articulated joint is provided for by a simple, rigid structure beneath the cylinders. A wrought iron brace 27¾ inches wide is bolted to the frames and spans the space beneath the cylinders. The brace is flanged at each end, the flange engaging the outside of each frame, so that side motion strains on the brace are taken up by the flanges. The brace is secured in position by horizontal bolts passing through the flanges and the bottom frame rails. Beneath the brace at its center a casting is bolted to provide a bearing for the lower end of the pin and this casting carries a plate on which the lower end of the pin rests, to hold it in position. The bearing for the upper end of the pin is provided by a casting bolted to the saddle casting on the seat to which the truck equalizer fulcrum was formerly secured. This casting includes a vertical tail which acts as a buffer for the rear end of the hinge casting carried by the forward section. The pin support under the high pressure cylinders is shown in one of the illustrations.

On the front section the hinge casting, or radius bar crosstie, is bolted to the frames in the usual manner. This casting is so designed as to brace the rear ends of the frames securely and to extend rearward to engage the pin carried by the structure beneath the high pressure cylinders. The details of design of this casting are also shown in the illustrations. The center of the pin is 5½ inches back of the transverse center line of the high pressure cylinders. It is 57½ inches back of the center of the rear drivers of the front section and 57½ inches forward of the center of the front drivers of the rear locomotive section, being located equidistant between the two sets of driving wheels.

In general, the design of the entire locomotive is a combination of the Santa Fe type locomotive and the Prairie Mallet type already in service on the Santa Fe System. The novelty of the design and construction is principally in the size of the locomotive produced and in the conversion of the largest type of locomotive on a single set of drivers to the largest locomotive of the Mallet type. The principal features are similar in details to designs developed by the Santa Fe System in some of its recent locomotives as well as similar to details common to the designs of Mallet locomotives constructed by the Baldwin Locomotive Works.

While the arrangement of steam piping is novel, it is in accord with practice followed by the Santa Fe in its latest purchase of locomotives, including Atlantic, Pacific and Mallet types. The arrangement is peculiar to the design used in connection with the Buck-Jacobs superheater. Steam is led from the dome of the rear section to the front flue sheet by the

*See AMERICAN ENGINEER, Dec., 1909, page 480.

original dry pipe. Here the old tee head is replaced by an elbow casting connecting the dry pipe with a steam pipe extension located outside of the boiler. This extension leads to the high pressure section of the superheater, entering the superheater shell to the left of the center line of the boiler. From points near the bottom of the high pressure section of the superheater, steam is led to each high pressure valve chamber by an individual pipe. Exhaust steam from the high pressure cylinders passes through the original exhaust connections of the old saddle. To the original exhaust pipe seat a long vertical exhaust pipe is connected. This pipe extends to the upper shell of the former smoke arch where it joints an elbow connected with a horizontal outside pipe. This pipe, in turn, leads to an elbow connecting with the low pressure section of the superheater. From the low pressure section of the superheater steam is led to the low pressure cylinders by the usual steam pipe beneath the boiler. By the arrangement of steam pipes described, the joints are on the outside where they are readily accessible, facilitating both inspection and repairs. The joints are removed from the intense heat which tends to cause leaks, and in the event of a leak the steaming qualities of the locomotive are not affected.

Both the high and low pressure cylinders are provided with piston valves. The high pressure valve is 13 inches in diameter and the low pressure valve is 15 inches in diameter. The valves on the original locomotives were actuated by the Stevenson valve gear. On the Mallet locomotive the valves of both the high and low pressure engines are actuated by the Walschaert valve gear. The valve motion is controlled by the Ragonnet reversing gear, a device designed by the Baldwin Locomotive Works, and already thoroughly described.

The ten locomotives being converted are to be placed in service west of Winslow, Arizona, and are equipped for burning oil as fuel. The greater evaporative capacity of the firebox applied, together with the application of superheater and feed water heater, provide for the greater power at the cylinders required by the larger locomotive.

The boiler of each original locomotive was fed by two No. 11 lifting injectors, each capable of delivering 3,800 gallons of water per hour. Each Mallet locomotive is equipped with two No. 12 non-lifting injectors, each capable of delivering 4,200 gallons of water per hour.

Compressed air is provided by two 8½ inch Westinghouse cross compound air pumps. The main reservoir includes three drums having a combined capacity of 100,000 cubic inches. One drum is carried on the right side of the rear boiler section and one drum on each side of the front boiler section.

The cab was designed to provide for the comfort of the engine crew when backing up, as well as when going ahead. Because of the unusual length of boiler it was considered best to provide for running the engine backward in case the long boiler should interfere with the vision of the engineer when running forward. In order that the track can be readily seen from the cab, when looking over the tender, the rear end of the tank is tapered in a manner somewhat similar to the incline at the back of switch engine tanks. A clear view past the tender is still further facilitated by rounding the corners of the tank.

The cab is of steel, lined on the inside with wood, in accordance with the usual design on the Santa Fe System. The back of the cab is entirely enclosed by a rear wall of sheet steel and access has been provided by two doors through this wall. Each door provides an opening 21¾ inches wide and the doors are 26½ inches apart. The upper portion of each door contains a pane of glass 15¾ in. x 34½ in. The doors swing open toward the center of the tank and away from the boiler head. In the extreme upper section of the rear cab wall are two ventilators opening 10 x 27 inches. These are closed by swinging sashes.

On the outside of the rear wall, between the doors, a sand box is mounted. This box is made of ⅛ inch sheet steel. It is 22½ inches long, 10½ inches wide by 27 inches deep. A swinging lid permits access to the sand box for filling. A sand valve is connected to the bottom of the box and protrudes into the cab. This valve provides a convenient arrangement for filling the funnel when necessary to sand the boiler flues. The inclined bottom of the sand box directs the sand toward the valve.

There is ample room between the sand box and the oil tank for a man to pass in moving from one side of the tender deck to the other.

The tenders were designed and constructed especially for the Mallet locomotives, the old tenders formerly applied to the original locomotives being assigned to locomotives in other classes. As explained, the contour of the tank is arranged to facilitate a view of the track from the cab when the engine is running backward. A short pilot is attached to the back end of the tender.

The water tank has a capacity of 12,000 gallons and the oil tank a capacity of 4,000 gallons. These are mounted on a built-up underframe of steel carried on two six-wheel trucks. The tender wheel base is 32 feet 6 inches and the trucks are spaced 22 feet between centers. The trucks and underframing are similar in general design to those under the tanks applied to the two passenger and two freight Mallet locomotives delivered to the Santa Fe during the latter part of 1909.*

In addition to the ten locomotives of the Santa Fe type being converted to the Mallet principle, four consolidation locomotives have also just been converted to that type. The general outline followed in converting the 2-10-2 type was observed in converting the 2-8-0 locomotives. The arrangement of feed water heater, superheater, steam connections, etc., is similar, the dimensions of course being modified according to the requirements of the smaller locomotive. The front section is mounted on a two-wheel front truck and four pair of driving wheels, the wheel base arrangement being the same as that of the locomotive converted.

The general dimensions, weights and ratios of the locomotives before and after conversion are given below:

	Original Locomotive	After Conversion
Classes	900 and 1600	3,000
Type	Santa Fe	Mallet
Service	Freight	Freight
Fuel	Bit. Coal and Oil	Bit. Coal & Oil
Tractive effort	62,800 lbs.	111,600 lbs.
Weight in working order	287,240 lbs.	616,000 lbs.
Weight on drivers	234,580 lbs.	550,000 lbs.
Weight, engine and tender in working order	466,240 lbs.	850,000 lbs.
Wheel base, total	35 ft. 11 in.	66 ft. 5 in.
Wheel base, engine and tender	66 ft.	108 ft. 1⅝ in.
RATIOS.		
Total weight ÷ tractive effort	4.58	5.52
Weight on drivers ÷ tractive effort	3.74	4.93
Tractive effort × diam. drivers ÷ heating surface	746	967
Total heating surface ÷ grate area	81.98	80.33
Firebox heating surface ÷ total heating surface, %	4.36	4.47
Weight on drivers ÷ total heating surface	48.91	83.60
Total weight ÷ total heating surface	59.9	93.63
Vol. equivalent simple cylinders, cu. ft.	17.2	30.2
Total H. S. ÷ cylinder volume	278.85	217.85
Grate area ÷ cylinder volume	3.4	2.71
CYLINDERS.		
Kind	Tandem Compound	Compound
Diameter	19 in. and 32 in.	28 in. & 38 in.
Stroke	32 in.	32 in.
		L. P. 15 in.
WHEELS.		
Driving, diameter over tires	57 in.	57 in.
Driving, thickness tires	3½ in.	3½ in.
Driving journals, main, diam. x length	11 x 12 in.	11 x 12 in.
Driving journals, others, diam. x length	10 x 12 in.	10 x 12 in.
Engine truck, diameter	29¼ in.	34¼ in.
Engine truck journals, diam. x length	6½ x 10½ in.	6½ x 10½ in.
Trailing truck, diameter	40 in.	40 in.
Trailing truck, journals, diam. x length	7½ x 11⅞ in.	7½ x 11⅞ in.
BOILER.		
Style	Extended wagon top	Same
Working pressure	225 lbs.	225 lbs.
Outside diameter of first ring	78¾ in.	79 in.
Firebox, width and length	108 x 78 in.	149⅝ x 78¾ in.
Firebox plates, thickness	Side and crown ⅜ in.	Channel 5/16 in.
	Flue 9/16 in.	Flue 9/16 in.
	Back ⅜ in.	Back ⅜ in.
Firebox, water space	F. 4½", B. 4", S. 3"	F. & B. 3", S. 3½"
Tubes, number and diameter	391—2¼ in.	377—2¼ in.
Tubes, length	19 ft. 11 in.	16 ft. 5 in.
Heating surface, tubes	4,587 sq. ft.	3,625 sq. ft.
Heating surface, firebox	209 sq. ft.	294.5 sq. ft.
Heating surface, feed water heater	———	2,659.5 sq. ft.
Heating surface, total	4,796 sq. ft.	6,579 sq. ft.
Superheating surface	———	2,328.4 sq. ft.
Grate area	58.5 sq. ft.	81.9 sq. ft.
TENDER.		
Wheels, diameter	34¼ in.	34¼ in.
Journals, diam. x length	5½ x 10 in.	5½ x 10 in.
Water capacity	8,500 gals.	12,000 gals.
Fuel capacity	3,000 gals. oil	4,000 gals. oil

* See AMERICAN ENGINEER, Dec., 1909, page 483.

Dynamometer Car of 110,000 Lbs. Capacity

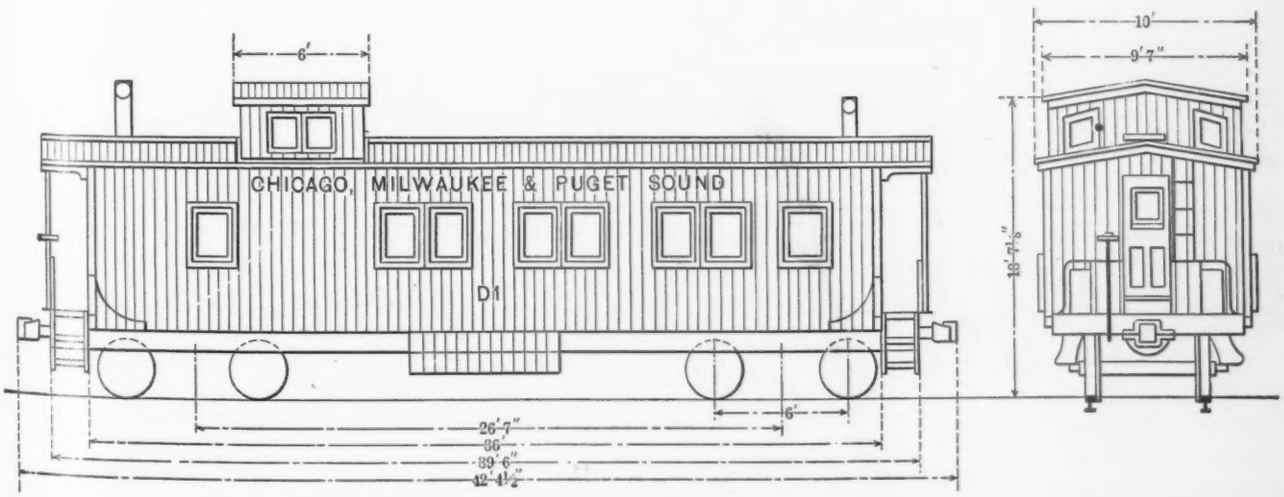
THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY HAS RECENTLY DESIGNED AND BUILT AT THE MILWAUKEE SHOPS, A 36 FT. DYNAMOMETER CAR WITH A MOST SUBSTANTIAL STEEL UNDERFRAME, WHICH INCORPORATES A SPRING DYNAMOMETER OF LARGE CAPACITY.

For testing large Mallet compound locomotives a dynamometer car is required of considerably larger capacity and of considerably greater strength of underframe than has been necessary in the past. The Chicago, Milwaukee & St. Paul Railway, desiring to obtain accurate information concerning the results of some Mallet compounds which were on order, designed and built at its shop at West Milwaukee the dynamometer car which is shown in the accompanying illustrations. These designs were drawn up in the mechanical engineer's office, under the supervision of J. F. DeVoy, assistant superintendent of motive power, and while incorporating no radical departures from the customary arrangement where a spring dynamometer is used, the car was evidently well fitted for the most severe and heavy service that it has since been called upon to undergo.

NEW DYNAMOMETER CAR OF 110,000 POUNDS CAPACITY DESIGNED AND BUILT BY THE C., M. & ST. P. RY.

Although the oil cylinder dynamometer is generally considered the best suited for this class of work, its advantages are not as great when used with the Mallet compound type of locomotive as with the ordinary simple engine. The former gives a very steady, even pull, is not subject to any considerable amount of slipping and in fact presents conditions wherein the spring dynamometer is reasonably satisfactory, particularly when the very great difference in original cost of apparatus and of the extreme care necessary for its proper maintenance is considered. In the present case the dynamometer consists of two sets of four springs each, the springs being made of 1 3/16 inch bar and having a height of 10 in. when under the initial compression of 100 lbs. Its total compression for the maximum capacity of 110,000 lbs. is 2.17 in. This gives a total movement of 5.42 inches to the pen point.

An inspection of the drawing will show that an underframe has been designed for this car which will assure perfect alignment and rigidity of the whole structure. It consists principally of a very heavy, strongly braced box girder center sill, built up of two 15 in., 33 lb. channels, extending continuous the full length of the car, a distance of 39 ft. 6 in., the web of each channel being reinforced for its full length with a ½ in. x 12 in. plate. These channels are spaced 14 in. apart and cover plates ⅜ in. x 21 in. are riveted on top and bottom. The superstruc-

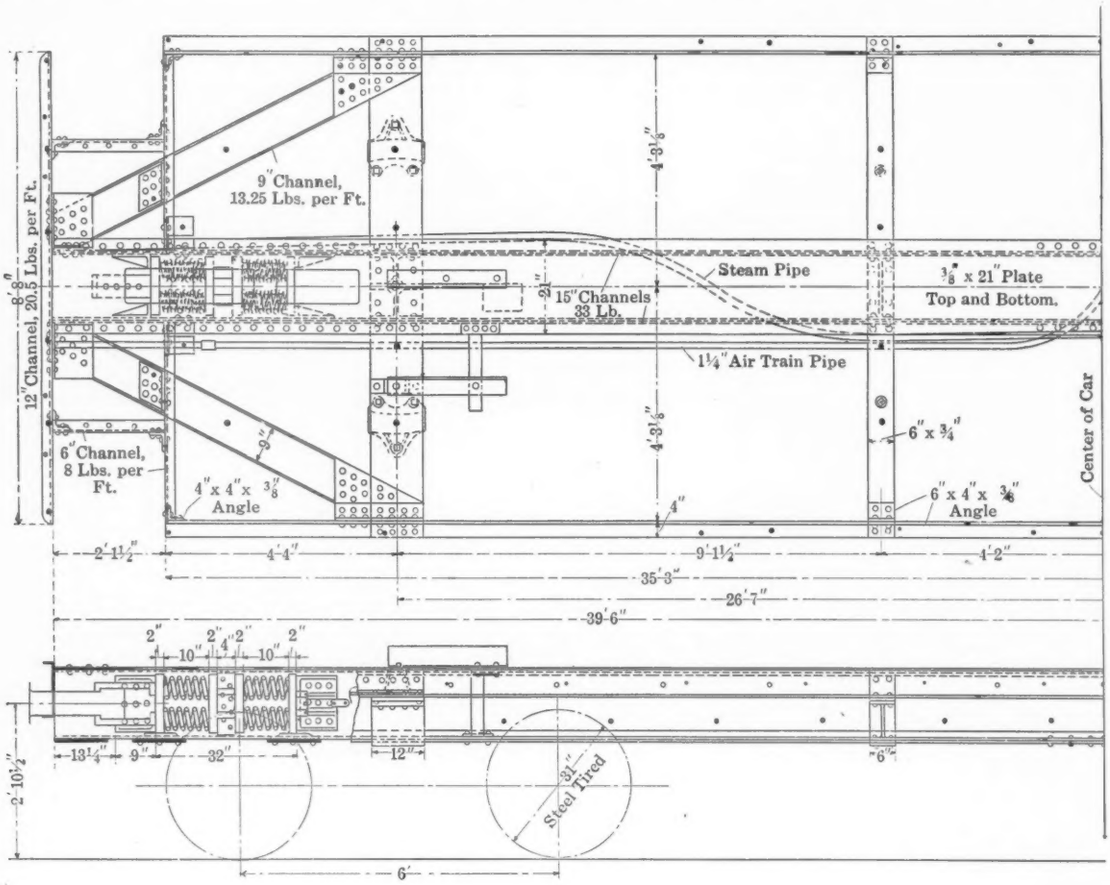


GENERAL DIMENSIONS OF NEW DYNAMOMETER CAR.

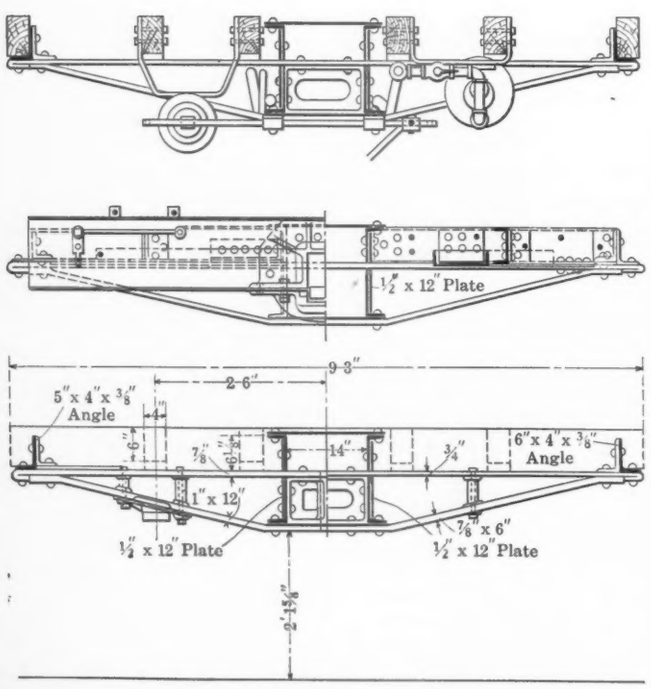
ture of the car is of wood and therefore the remainder of the underframe is of comparatively light construction. The side sills are 6 x 4 x ⅜ in. angles continuous for the full length of the car body and the end sills are 6 in. channels. The bolsters and two cross bearers, spaced equally between, are of the simple truss type, the bolsters having a ⅞ x 12 in. tension member and a 1 x 12 in. compression member. The cross bearers have a ¾ in. top plate and a ⅞ in. bottom plate 6 in. in width. The upper members of both the bolsters and cross bearers pass through openings cut in the center sill channels and a stiffening and reinforcing casting is inserted at this point.

Supported on this steel underframe are six longitudinal wooden sills, 4 x 6 in. in section. These are securely bolted and fastened to the steel members, especially to the side sills, and on this is erected a wooden superstructure of the customary light passenger car type.

The paper driving mechanism consists of a bronze bushing, incorporating a 6 in. diameter gear, keyed to the inner axle of



VERY HEAVY STEEL UNDERFRAME ON NEW DYNAMOMETER CAR.



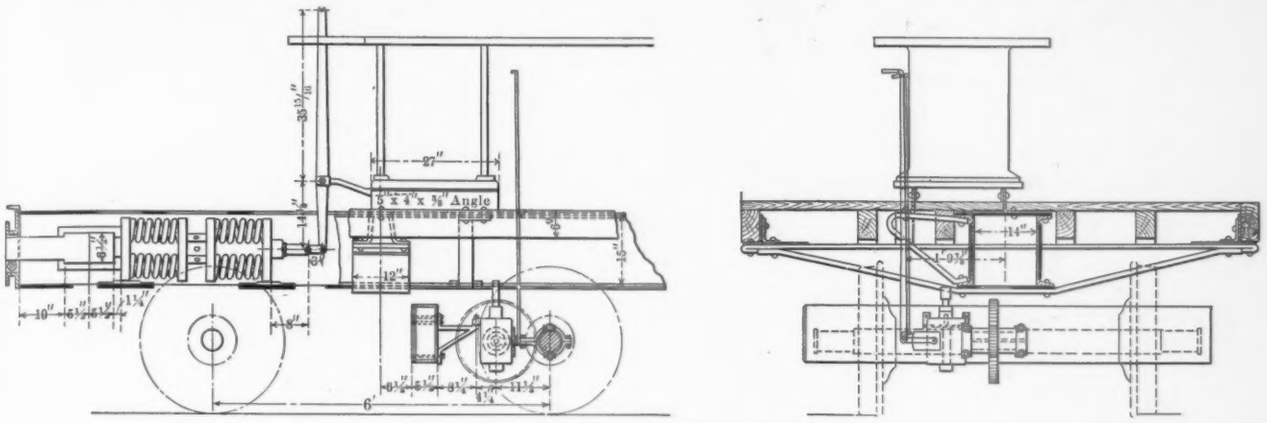
SECTION OF STEEL UNDERFRAME.

the truck at the dynamometer end of the car. This pinion meshes with a 17 in. gear keyed to a short shaft on which is carried a small bevel gear enclosed in the reversing box. This shaft and the other mechanism is carried in a frame supported on the bronze bushing on the axle and a bracket extending out from the truck frame, as is shown in one of the illustrations. On the vertical driving shaft there are two bevel gears, both in mesh with the one just mentioned and running free. Between them there being a clutch to engage the proper one to give the correct movement of the paper roll. A universal joint is placed in this shaft just above the floor of the car to take care of the effect of the movement of the truck and above this joint are the worms driving the paper rolls in the customary manner, this of course being on the recording table frame. The axle to which this mechanism is connected carries 30⅞ in. steel tired wheels and the construction is such that the vertical shaft makes 234.2 revolutions per mile, giving 4.4 ft. movement of the paper in that distance.

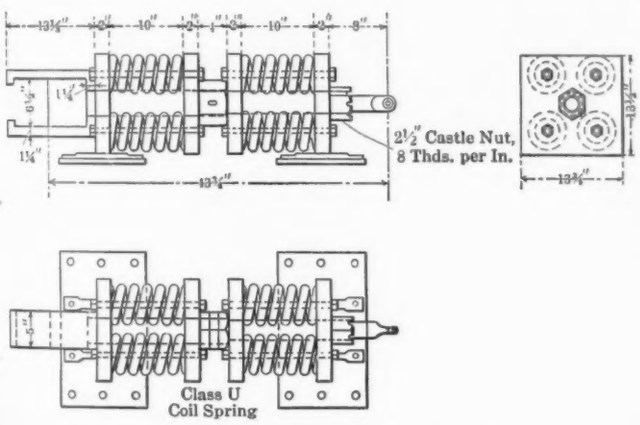
The pull from the coupler shaft is carried to the dynamometer by means of a large steel shaft in the center between the springs, the inner end of which is linked to a vertical rod, which is pivoted so as to give a 2½ in. movement at the upper end for a 1 in. movement of the draw bar. The upper end is connected through a link with the customary straight line pen carrying bar supported in guides over the top of the recording table.

On the recording table are instruments for making six records on the roll. At one side is the pen connected to the chro-

nometer, which receives an impulse at five second intervals and gives the speed data. Next to this is a pen operated by a circuit from the cab by means of which the throttle and reverse lever positions are recorded. Next comes the pen giving datum line for determining the draw bar pull adjoined by the record of the movement of the coupler itself. These two records are, of course, in the center of the sheet. On the opposite edge is a pen controlled by a circuit from the cab giving an indication of when cards are taken. Above this is the pen controlled from the lookout, by which all mile posts, stations and other permanent objects along the right of way are indicated. All of this apparatus on the recording table is most substantial and accurately constructed.



CONNECTION FOR RECORDING APPARATUS.



DETAILS OF SPRING DYNAMOMETER.

Altogether the car is but 36 ft. in length, the arrangement is such as to make it very roomy while at the same time including such conveniences as are practically necessary on a car of this character. There are four upper and two lower berths; plenty of storage space and a coal stove arranged for cooking if necessary.

The trucks under the car are of the standard arch bar type of heavy and substantial construction, the bolsters being very rigidly built of steel plates and angles and carried on four double elliptic springs. The axles are M. C. B. 60,000 lbs. and the wheels measure 30⅞ in. in diameter. The car has a total weight of 53,100 lbs.

ANNUAL CONVENTION OF THE INTERNATIONAL RAILWAY FUEL ASSOCIATION.—The third annual convention of this association will be held at Chattanooga, Tenn., May 15 16, 17 and 18, 1911. Hours of session from 9 A. M. to 1 P. M. daily, excepting May 17, when there will be morning and afternoon sessions. Subjects of papers for reading and discussion: "Fuel Investigations Under the Bureau of Mines," Dr J. A. Holmes, chairman, director Bureau of Mines; "How to Organize a Railway Fuel Department and Its Relations to Other Departments," T. Duff Smith, chairman, fuel agent Grand Trunk Pacific Railway; "The Testing of Locomotive Fuel," F O. Bunnell, chairman, engineer of tests Rock Island lines; "Standard Locomotive Fuel Performance Sheet," F. C. Pickard, chairman, A. M. M., C. H. & D. Ry.; "The Railway Fuel Problem in Relation to Railway Operation," R. Emerson, chairman, engineer track economics A. T. & S. F. Ry.; "Petroleum, Its Origin, Production and Use as Locomotive Fuel," E. McAuliffe, chairman, general fuel agent 'Frisco lines.

ELECTRIC LOCOMOTIVES FOR PANAMA

Tenders are being invited for electric locomotives of a unique type for service on the Panama Canal. They will be run on a rack railway and be put to the duty of towing vessels through the waterway. In the design formulated by the Isthmian Commission these towing locomotives are shown for construction in three sections, of which the front and rear are to be mounted on rigid four-wheel trucks, each driven by an independent motor, while the middle section is connected to the two tractive elements by universal joints, and is equipped with a slip-drum towing windlass and hawser, so that the line may be veered and hauled at pleasure without any motion of the locomotive along the track.

In towing, the locomotive derives its tractive effort from one of the end elements through a pinion engaging a shrouded semi-suppressed rack anchored in the coping. The side pull of the hawser is taken up by horizontal thrust wheels which bear on the side of the track. The current for the operation of the locomotives will be taken from underground circuits. The maximum pull on the tow line is fixed at 25,000 lbs., at which force a friction coupling will relieve further strain. The central racks are to be provided only on the towing tracks and inclines. On the level portion of the return tracks the locomotives will run by friction on the side rails after the fashion of the ordinary electric railway.

THE MAXIMUM EXPORT OF STEEL RAILS was reached in 1904, when 414,845 tons, valued at $10,661,222, were sent to foreign countries. The year of next largest exportation was 1900, in which year we sent to foreign lands 356,245 tons, valued at $10,985,106. Last year, which was the third largest year in our steel rail export trade, there were 353,180 tons of rails sent abroad, the home value of which was $10,162,522. The average value per ton of the rails exported in 1904 amounted to only $25.70, while in 1910 the average value was $28.77 per ton, a difference of $3.07. In each of these years the price of steel rails at mills to domestic consumers was $28 per ton.